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C H A R L E S T O W N

NAVY YARD

R E D E V E L O P M E N T

Final

S U P P L E M E N T A L

ENVIRONMENTAL IMPACT REPORT

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APPENDIX A

REVISED DESIGN GUIDELINES FOR THE NEW DEVELOPMENT AREA

AMENDMENT TO DESIGN GUIDELINES
FOR THE NEW DEVELOPMENT AREA,
CHARLESTOWN NAVY YARD

This Amendment to Design Guidelines for the New Development Area, Charlestown Navy Yard ("Amendment") is made as of this 19th day of July, 1991, by and among the Massachusetts State Historic Preservation Officer ("MSHPO"), the Advisory Council on Historic Preservation ("ACHP"), and the Boston Redevelopment Authority ("BRA") (collectively hereinafter the "Parties").

The following facts and circumstances are pertinent to the making of this Amendment:

- A. On May 21, 1979, the General Services Administration ("GSA") conveyed to the BRA a 58.4 acre portion of the Charlestown Navy Yard, which portion is commonly referred to as the "New Development Area" or "Buy Parcel."
- B. Said conveyance was made subject to a Memorandum Of Agreement ("MOA") executed in June of 1978, by and among the GSA, ACHP, and MSHPO, with the concurrence of the BRA. Among other things, the MOA established certain design guidelines, dated June 1978 ("Design Guidelines"), to which subsequent restoration, rehabilitation, demolition, and new construction activities were required to conform.
- C. Since the original conveyance, the New Development Area has been substantially redeveloped in accordance with the Design Guidelines.
- D. On October 11, 1990, the Board of the BRA adopted a new master plan ("Master Plan") for the Yard's End portion of the Charlestown Navy Yard.
- E. In order to permit implementation of the Yard's End Master Plan in accordance with the terms of the MOA, it is the desire of the Parties to amend the Design Guidelines as set forth herein.

NOW THEREFORE, in consideration of the mutual covenants and agreements herein contained, the Parties agree to amend the Design Guidelines as follows:

1. Definitions. For the purposes of this Amendment and the MOA, the following terms and phrases have the meanings ascribed:

"Building Height" shall mean, excluding mechanical roof structures, penthouses, masts, spires, roof structures, and other structures normally built above the roof and not used or designed to be used for human occupancy, (a) for a flat roof, the vertical distance from the grade to the top of the highest point of the roof beams and (b) for a pitched roof, the vertical distance from grade to the lower of (i) the mean level of the highest gable or of the slope of a hip roof or (ii) the top of the structure of the highest occupied floor. For Piers, grade shall be measured from the top of the deck of the Pier.

"Design Guidelines": Those certain design guidelines identified in paragraph B above.

"Master Plan": That certain Master Plan identified in Paragraph D above.

"New Parcels": Those certain parcels identified as "4A," "4B," "5," "6," and "7" on Exhibit A, attached hereto and incorporated herein.

"Permitted Use(s)": The principal or predominant use(s) of a site. The designation of a Permitted Use or Uses shall not be deemed to exclude accessory and incidental uses.

2. Subsection II(c)(2) of Part 2 of the Design Guidelines, which subsection is entitled "New Construction" is amended by adding the following new paragraph (d):

(d) **ROOFTOP MECHANICAL EQUIPMENT:** Mechanical equipment can enhance the industrial character of the Navy Yard by adhering the following four guidelines:

(i) Separation: Equipment should be desegregated wherever possible and not connected together in a single mass.

(ii) Design: The location and composition of the equipment must minimize its visual impact on the surrounding areas.

(iii) Unscreened: Large screens should be avoided; the scale and irregularity of the equipment should be allowed to be seen.

(iv) Setback: Mechanical equipment must be located sufficiently back from the parapet to minimize its visibility from pedestrian right-of-ways immediately adjacent to the structure.

3. The parcel controls for Parcel 1B, set forth in Part 3 of the Design Guidelines are amended as follows:

(a) in subsection 3(b), entitled "Height," by deleting the phrase "2 1/2 stories or 35 feet" and inserting in lieu thereof "55' except that within 35 feet of the seaward end of the pier there shall be a no-build area."

(b) in subsection 3(c), entitled "Parking," by inserting before the period at the end of the sentence the following:

"consistent with the Yard's End Master Plan"

(c) in subsection 3(d), by inserting, after the word "consistent," the following:

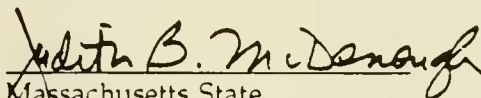
"with the Yard's End Master Plan and"

4. With respect to Parcels 4A, 4B, 5, 6, and 7, the parcel controls set forth in Part 3 of the Design Guidelines are hereby rescinded and the parcel controls set forth in Exhibit B for the corresponding New Parcels are substituted in lieu thereof. For parcels other than said Parcels 4A, 4B, 5, 6, and 7, the parcel controls set forth in said Part 3 remain applicable, except as modified in Sections 2 and 3 above.

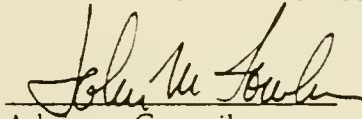
5. This agreement constitutes an approval under M.G.L. C. 9 sec. 26-27C as amended (950 CMR 71.00) of the Amended Design Guidelines on proposed developments on Parcels 1B, 4A, 4B, 6 and 7, subject only to design review which will not reduce the density or height of any development permitted by operation of the design restrictions.

6. Except as expressly modified hereby, the provisions of the Design Guidelines are hereby ratified and confirmed.

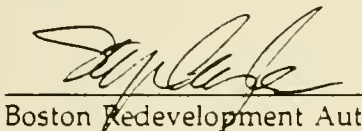
IN WITNESS WHEREOF, the parties have executed this Amendment as of the day and date first above written.



Massachusetts State
Historic Preservation Officer



Advisory Council on
Historic Preservation



Boston Redevelopment Authority

Attachments

Exhibit A - Plan Showing New Parcels

Exhibit B - Design Guidelines for New Parcels

EXHIBIT A
PLAN SHOWING NEW PARCELS

EXHIBIT B
DESIGN GUIDELINES FOR NEW PARCELS

New Parcel 4A

1. SITE DATA

A. LOCATION:

Between Thirteenth and Sixteenth Streets, First Avenue and the water.

B. PARCEL:

Approximately 2.3 acres of land.

C. EXISTING STRUCTURES:

None.

2. PERMITTED USES

Hotel, conference center, residential, office, retail, restaurant, parking, marina and marina amenities.

3. PARCEL CONTROLS

A. HEIGHT:

The maximum building height of new construction shall not exceed 135 feet, except that within 50 feet of southwesterly boundary of New Parcel 4A, the maximum building height shall not exceed 90 feet.

B. ACCESS:

Vehicular access to the site shall be via First Avenue and an extension of Sixteenth Street.

C. PARKING:

Sufficient parking shall be provided to satisfy the demand generated by the proposed uses, consistent with the Yard's End Master Plan.

D. PUBLIC ACCESS:

Continuous public pedestrian access shall be provided along the entire water's edge.

E. MATERIALS:

New construction shall be concrete, masonry, metal and glass.

New Parcel 4B

1. SITE DATA

A. LOCATION:

Pier 9.

B. PARCEL AREA:

Approximately 1 acres of pier, and 3.1 acres of water.

C. EXISTING STRUCTURES:

Pier Nine was constructed with wood piles and wood deck.

2. PERMITTED USES

Marina and marina amenities.

3. PARCEL CONTROLS

A. EXISTING STRUCTURES:

Pier Nine may be demolished.

New Parcel 5

1. SITE DATA

A. LOCATION:

Dry Dock Five, Pier Eleven and Pier 10 area.

B. PARCEL AREA:

Approximately 1.8 acres of land, 2.1 acres of pier, 1.4 acres of dry dock and 1.2 acres of water.

C. EXISTING STRUCTURES:

Dry Dock Five was constructed in 1942 of concrete with steel sheeting.

Pier Eleven was constructed in 1956 with end-bearing concrete filled steel pipe piles and a concrete deck.

Pier Ten was constructed with wood piles and wood deck.

Building 226 is a one-story structure with steel frame, masonry walls and steel industrial sash.

2. PERMITTED USES

Aquarium/Cultural, hotel, residential, restaurant, retail, office, research & development, marina, marina amenities, and parking.

3. PARCEL CONTROLS

A. EXISTING STRUCTURES:

Dry Dock Five shall be retained, repaired and remain flooded, or covered and used in a manner consistent with Aquarium uses.

Pier Eleven shall be retained.

Building 226 may be demolished.

B. HEIGHT:

The maximum building height of new construction shall be 110 feet.

C. PARKING:

Sufficient parking shall be provided to satisfy the demand generated by the proposed uses, consistent with the Yard's End Master Plan.

D. PUBLIC ACCESS:

Continuous public pedestrian access shall be provided along the entire water's edge.

E. MATERIALS:

New construction shall be concrete, masonry, metal and glass.

F. ACCESS:

Vehicular access shall be via an extension of Sixteenth Street and an extension of First Avenue.

New Parcel 6

1. SITE DATA

A. LOCATION:

East of Sixteenth Street, between First and Second Avenues.

B. PARCEL AREA:

Approximately 1.5 acres of land and 0.3 acres of pier.

C. EXISTING STRUCTURES:

Building 131 is a three-story concrete and brick masonry structure.

Building 206 is a two-story wood frame building constructed in 1942 as an office.

Building 225 is one-story concrete and masonry building.

2. PERMITTED USES

Research and development, light manufacturing, office, restaurant, retail, parking.

3. PARCEL CONTROLS

A. EXISTING STRUCTURES:

All existing structures may be demolished.

B. HEIGHT:

The permitted height of new construction shall be 110 feet. Any further change in height of new construction, or portions thereof, on Parcel 6 shall be jointly determined by the BRA, the Massachusetts SHPO, and the ACHP.

There shall be a 60-foot no build area on Parcel 6 bordering Sixteenth Street. The no build area will serve to mitigate height next to the Historic Monument Area.

C. PARKING:

Sufficient parking shall be provided to satisfy the demand generated by the proposed uses, consistent with the Yard's End Master Plan.

D. PUBLIC ACCESS:

Continuous public pedestrian access shall be provided along the entire water's edge. Vehicular access shall be via Sixteenth Street and an extension of First Avenue.

E. MATERIALS:

New construction shall be concrete, masonry, metal, and glass.

F. ACCESS:

Vehicular access shall be via Sixteenth Street and an extension of First Avenue.

New Parcel 7

1. SITE DATA

A. LOCATION:

East of Sixteenth Street between Second Avenue and Building 114.

B. PARCEL AREA:

Approximately 3.5 acres of land.

C. EXISTING STRUCTURES:

Building 178 is a one-story frame wood storage shed.

Building 193 is a two-story concrete and brick masonry scrap salvage building.

Building 203 is a two-story incinerator with steel and concrete frame and clad with sheet metal.

Building 227 is a one-story gas storage shed.

Building 165 is a two-story concrete and brick masonry structure.

2. PERMITTED USES

Research and development, light manufacturing, office, restaurant, retail, and parking.

3. PARCEL CONTROLS

A. EXISTING STRUCTURES:

All existing structures may be demolished.

B. HEIGHT:

The maximum Building Height of new construction shall be 155 feet, except that Building 1, a component of the proposed Research Center referenced in the Notice of Project Change on the Charlestown Navy Yard Redevelopment (EOEA File No. 2383) received by the Secretary of the Executive Office of Environmental Affairs on October 31, 1990, shall be limited to a Building Height of 140 feet.

C. PARKING:

Parking shall be provided to satisfy the demand generated by the proposed uses, consistent with the Yard's End Master Plan.

D. PUBLIC ACCESS:

Continuous public pedestrian access shall be provided along the entire water's edge.

E. ACCESS:

Vehicular access shall be via Sixteenth Street and an extension of First Avenue. There is no obligation to create a new street by extending Second Avenue into Parcel 7.

F. MATERIALS:

New construction shall be constructed of materials which are compatible with those of adjoining existing or proposed structures.

APPENDIX B

STABILIZATION REPORT FOR THE ROPEWALK, TAR HOUSE, AND CHAIN FORGE

90V91-2274

STABILIZATION REPORT

ROPEWALK - BUILDING 58
TAR HOUSE - BUILDING 60
CHAIN FORGE - BUILDING 105

CHARLESTOWN NAVY YARD
BOSTON REDEVELOPMENT AUTHORITY
BOSTON, MASSACHUSETTS

Prepared by:
McGinley Hart & Associates
Architects & Preservation Planners

Boston Building Consultants, Inc.,
Structural Engineers

April, 1991

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COST ESTIMATES

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- CHAIN FORGE; BUILDING 105

HAER DRAWINGS of the ROPEWALK & TAR HOUSE

PRELIMINARY REHABILITATION GUIDELINES for the CHAIN FORGE

INTRODUCTION

As part of the ongoing efforts to develop and interpret the buildings within the Historic Monument Area of Charlestown Navy, the Boston Redevelopment Authority is committed to the stabilization and maintenance of these buildings to thwart further degradation of historic fabric.

Building surveys, both architectural and structural, have been conducted to determine the existing conditions of the historic fabric of the Ropewalk, Building 58; the Tar House, Building 60; and the Chain Forge, Building 105.

McGinley Hart & Associates have prepared this report which includes summary cost estimates for temporary stabilization based on the findings of site inspections as well as discussions of existing conditions of architectural and structural components. Illustration of each building are included for reference.

Structural degradation is discussed in detail in the attached report compiled by Boston Building Consultants, structural engineering consultants.

Boston Redevelopment Authority						April 2,1991		
	McGinley Hart & Associates							
	Boston Building Consultants							
COST ESTIMATE SUMMARY FOR STABILIZATION								
DESCRIPTION								
Building 58								\$72,818
	ROPEWALK							
Building 60								7,935
	TARRING SHED							
Building 105								145,492
	CHAIN FORGE							
TOTAL								\$226,245

Boston Redevelopment Authority						April 2,1991	
	McGinley Hart & Associates						
	Boston Building Consultants						
COST ESTIMATE SUMMARY FOR STABILIZATION							
DESCRIPTION							
Building 58							\$72,818
	ROPEWALK						
Building 60							7,935
	TARRING SHED						
Building 105							145,492
	CHAIN FORGE						
SUBTOTAL							\$226,245
General Conditions @15%							33,937
Profit @ 10%							26,018
Contingency @ 10%							\$28,620
TOTAL							\$314,820



Cost Estimate to Stabilize Building 58			Date: April 2, 1991		
Building 58		Ropewalk	McGinley Hart & Associates		
Charlestown Navy Yard			Boston Building Consultants		
		TOTAL			
DESCRIPTION		QUANTITY*	COSTS	UNITS	TOTAL
Structural					
Shore failed truss (HABS-HAER #101)		1	5000	@	5,000
Remove & replace flooring @ failed truss		1	2000	@	2,000
Metals					
Secure ventilators		2	300	@	600
Secure iron shutters		3	25	@	75
Secure sheet metal siding		170	1	sf	170
Remove dangerous conduit & piping		260	3	lf	780
Remove damaged snow guard and gutter		100	5	lf	500
Install sheetmetal covers @ all skylights		228	3	sf	684
w/ vents		46	15	sf	684
Wood and Plastics					
Rebuild roof penthouse		5	500	@	2,500
Patch existing holes in floor		20	20	@	400
Thermal and Moisture Protection					
Secure or provide ridge cap		710	10	lf	7,100
Secure flashing		655	6	lf	3,930
Slate roofing		2,313	12	sf	27,750
Patch roof underlayment		925	5	sf	4,625
Temp. plywood & rubber roof @ failed truss. Salvage ex'st'g slate for reuse.		1	3,000	@	3,000
Doors and Windows					
Secure existing plywood @ openings		72	10	@	720
Paint & Install temp. perforated plywood covers		1,650	6.00	sf	9,900
Secure dormers		2	500	@	1,000
Install chainlink fence gates @ doors		2	700	@	1,400
SUBTOTAL					\$72,818
* Estimated quantites have been derived from visual inspection only.					
Additional areas of repair may be identified as stabilization work proceeds					
M/480/BRAjes/3/14/91					

[illegible]

Cost Estimate for Temporary		April 2,1991	
Stabilization of Building 105			
BUILDING 105 Chain Forge		McGinley Hart & Associates	
Charlestown Navy Yard		Boston Building Consultants	
DESCRIPTION		TOTAL QUANTITY*	COSTS UNIT TOTAL
Structural			
Strap piers w/ galv. straps and anchors	26	150	@ 3,900
Patch holes	3	200	@ 600
Reset cornice brickwork	500	20	lf 10,000
Reset Dentil & Cornice Corners	44	200	@ 8,800
Rebuild dentil and cornice corners	16	1700	@ 27,200
Rebuild pier capitals	19	200	@ 3,800
Platform lift or staging	8	1200	wk 9,600
Metals			
Ventilators (secure)	16	300	@ 4,800
Sheet metal roofing (secure)	3,100	1	sf 3,100
Rooftop ventilator (secure)	560	5	sf 2,800
Install sheetmetal covers @ all skylights	628	3	sf 1,884
Secure monitor siding	300	1	sf 300
Thermal and Moisture Protection			
Replace damaged wood decking	6,000	5	sf 30,000
Temporary rolled roofing	8,000	2	sf 16,000
Secure copper trim	870	6	lf 5,220
Gutter liner	400	5	lf 2,000
Downspouts	500	4	lf 2,000
Doors and Windows			
Install temporary protective cover	5,752	2	sf 11,504
Arched openings (plywood)	332	4	sf 1,328
Misc. additional openings (plywood)	164	4	sf 656
SUBTOTAL			\$145,492
* Estimated quantities have been derived from walk through inspection. Additional areas of repair may be identified as stabilization work proceeds.			
M/480/BRAjes/3/14/91			

ARCHITECTURAL COMPONENTS
OF
BUILDING STABILIZATION

Ropewalk; Building 58

Existing original slate roofing appears for the most part to be in sound condition. Individual slates are broken and fractured throughout the almost 90,000 square foot of roof surface. There are, however, some isolated areas where the slate roofing is deteriorated enough to allow moisture to penetrate the building envelope and begin to affect the wood decking and structural elements below.

In this instance a limited life repair with a non - historic material is not recommended. Any temporary patching effort is likely to cause additional damage to surrounding slates. With the exception of an area of roof adjacent to the a failed truss, removal and stockpiling of slates for reuse, coupled with the repair of deteriorated underlayment and the replacement of the missing ridge cap elements is recommended to stabilize the roof system.

A directly adhered rubber roof is recommended as a temporary repair for the area of roof which has failed in conjunction with the structural truss failure. The existing slate should be removed and either stockpiled for later reuse, or reused in conjunction with the slate roof repairs.

Fitted and properly flashed metal covers should be installed over all existing skylights to prevent additional moisture infiltration. One third of the covers should have an integral ventilator to allow some degree of air exchange throughout the building.

The design and construction of the five existing wood penthouses is quite basic. Temporary stabilization of these structures from further deterioration should not damage existing historic fabric. An accurate restoration, based on the existing rehabilitation guidelines of the penthouses, would be the preferred alternative in this instance.

Several small access doors exist in the flooring throughout the first floor of the building. Covers should be installed to eliminate the danger of tripping and falling, especially in poorly lighted areas.

The drainage system of the Ropewalk is for the most part extinct. Remnants of the gutter and leader system are hanging loose at the Headhouse as are the remainder of original snow guards at the roof. These systems provide no protection for the building and should be removed to avoid further damage or injury. Snow guard profiles, including configuration and method of attachment, should be well documented upon removal. These sections should be cataloged and properly stored to facilitate their reuse when the building is restored.

Sheet metal siding, located at the west elevation of the second floor, as well as formed metal ventilators at the roof ridge should be checked to determine that they are securely attached and weather tight.

There has been steady deterioration of the window fabric through vandalism and lack of maintenance. Many window openings have already been infilled and or covered with painted plywood. Broken windows throughout the building, however, have actually helped to maintain ventilation and allow moisture to escape. Protection of the remaining windows is essential. Existing security grills which have become dislodged from their original locations should be refastened. In addition, the remaining exposed windows (especially the north, Chelsea Street side) of the first floor should be secured with painted plywood which has been perforated to allow continued ventilation. The installation of heavy duty chain-link gates at both the two doorways of the one story portion of the building will provide ventilation as well as access and security.

Tar House; Building 60

The Tar House has a slate roof on wood decking. Similar to the Ropewalk there are several areas where deteriorated or missing slate have allowed moisture to penetrate to the interior spaces. These areas should be repaired with matching slate and replacement of any deteriorated wood decking.

The three roof penthouses should be repaired in accordance with the rehabilitation guideline.

Existing iron shutters, doors and loose flashing throughout the building should be secured.

There is evidence that moisture has repeatedly infiltrated the basement. Standing water has accumulated 2"-3" deep. Infilled basement windows which are set below the present grade in lightwells are probably the source of most of the infiltration. A temporary plywood cap at each lightwell will help to divert water away from the open masonry joints.

Window openings for the most part have been infilled with plywood on the Tar House. However, these plywood covers should be secured as site inspection has revealed several to be loosely fitted to the masonry and easily dislodged. Any new plywood infill should be painted to match existing.

Chain Forge; Building 105

Slate roofing on the Round House portion of the building is in good condition, although large areas of replacement slate do not match the original adjacent slates. No patching is needed in this area.

Repairs of deteriorated roof areas in the Forge Shop and Connector Building can be accomplished with a rolled roofing over new wood decking as needed.

Skylights can be treated similarly to those at Ropewalk and the Tar House. Ventilated sheet metal covers should be installed and flashed at the roof to ensure a weather tight seal. Existing deteriorated covers at skylights should be replaced with similarly fitted sheetmetal covers.

Existing monitor siding, sheetmetal, copper roofing and trim should be carefully checked for sound attachment. Missing areas and holes should be patched with temporary rolled roofing over new pressure treated substrate. Roof top ventilators and stacks should also be checked and secured if attachment is deteriorated.

Portions of a gutter system remain at the Round House although severely weathered and allowing moisture to enter and degrade the masonry walls behind and below. A short term (not more than 10 years) solution to this problem would be to install an uncured, neoprene sheet liner for the full length of the gutter system. No system of leaders remain at this time; remnants of the leader system penetrate the sidewalk vault making their terminal points highly suspect. Temporary galvanized drain leaders should be installed on the face of the building from the gutters to grade.

Wood industrial sash windows at the 1943 north extension are deteriorating. Hopper sections are loose and unsecured allowing additional moisture to penetrate the building envelope. These extremely large windows provide the only illumination to the interior of the building which is filled with numerous uncovered holes and machine pits. Sealing them with a protective but transparent medium is highly recommended. Hopper sections should be secure. Wooden frames large enough to cover several windows with hardware cloth (a woven wire fabric) can be stretched and nailed to each frame to protect the windows from additional breakage due to vandalism and allow light to enter the building.

Report

to

McGinley Hart & Associates
77 North Washington Street
Boston, Massachusetts 02114

from the

Boston Building Consultants
79 Milk Street
Boston, Massachusetts 02109

on the

Scope of Stabilization Repairs

to

Building 58
Ropewalk Building
Charlestown Navy Yard
Boston, Massachusetts

April 2, 1991

B O S T O N B U I L D I N G C O N S U L T A N T S

79 Milk St. Boston MA 02109

6 1 7 / 5 4 2 3 9 3 3

Building 58
Ropewalk Building

Introduction:

As part of the Boston Redevelopment Authority's (BRA) plans to stabilize Building 58, the Ropewalk Building, in the Charlestown Navy Yard and at the request of their architectural consultant, McGinley Hart & Associates (MHA), Boston Building Consultants (BBC) surveyed the structural condition of the Building. BBC understands the BRA plans to repair the building to ensure its structural stability and prevent short-term (10 years) deterioration of its components. To provide the BRA with a scope of work to stabilize the building, BBC is reporting on structural damage, its causes, recommendations for repairs, and a corresponding budget.

On February 13, 1991, Arthur Brown and Arthur MacLeod, both of BBC, surveyed the building in detail. The basement was not surveyed because of a lack of access.

Building Description:

Located in the northwest area of the Yard, the Ropewalk is a narrow building about 1/4 mile long. The headhouse, a three-story building with masonry (stone and brick) walls and wood floor and roof framing, is located at the northeast end. A two-story section of the building extends from the headhouse approximately 760'. The remaining one story section is approximately 420' in length. The exterior walls are constructed of granite facing backed up by brick. Skylights penetrate the roof plane at irregular intervals. The floors are framed with wood. Timber trusses, joists, and board decking support the slate roof.

Overall condition:

Many windows on the first floor have broken window panes. On the second floor, much of the glass is intact and the windows are either closed or covered. The effect has provided ventilation to the first floor keeping materials relatively dry, whereas the second floor is unventilated and materials are damp.

B O S T O N
B U I L D I N G
C O N S U L T A N T S

Building 58
Ropewalk Building

Problem Identification and Evaluation:

On the second floor of the Ropewalk and floors of the headhouse, wood flooring has buckled. This buckling resulted from inadequate ventilation and local roof leaks. If the spaces are not ventilated, moisture will rot the wood framing thereby rendering it structurally unfit.

In the portion of the building next to the headhouse, a large timber truss (about 60 feet long) is rotting. The roof supported by it has dropped about four inches. Water appears to be entering through flashing in the adjoining wall. If left unshored, the truss could collapse.

In the two-story section of the building, a few holes can be seen in the roof. Slates are missing at these holes. Wood roof framing and decking is rotting where exposed to water entering through the holes.

Some skylights have holes in them. Water is entering and rotting the surrounding wood framing.

In some locations of the southeast exterior wall in the two-story section of the building, the paint has cracked at a gap between the wall and the sill on top of it. The gap is 1/4 inch wide. It gives the appearance that the wall has tipped outward. The wall moved while the sill anchored to the truss did not.

Conclusions:

In general, the building is in good condition. Roof repairs should be made to avoid further water infiltration. If ventilation is not improved, the building could quickly deteriorate. The few problems that were found could cause more severe problems if not corrected.

Recommendations:

Boston Building Consultants recommends the following:

1. Improve ventilation with appropriate use of windows, doors and roof hatches.
2. Shore the failed truss by building a temporary wood stud bearing wall under it.

B O S T O N
B U I L D I N G
C O N S U L T A N T S

Building 58
Ropewalk Building

3. Install crack monitors and measure the gap between the exterior wall and sill. Then monitor the gap for movement.
4. Repair holes in the roofing, flashing, and skylights.

The costs for stabilization repairs described above are included in an overall budget which is being prepared separately from this report.

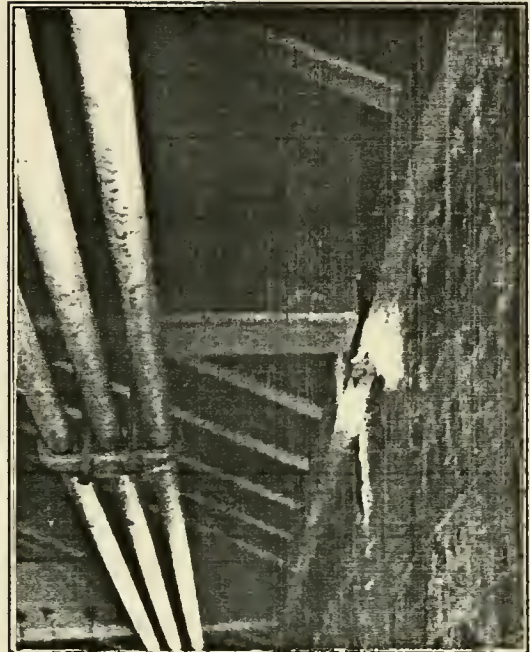
Sincerely,

Arthur H. MacLeod

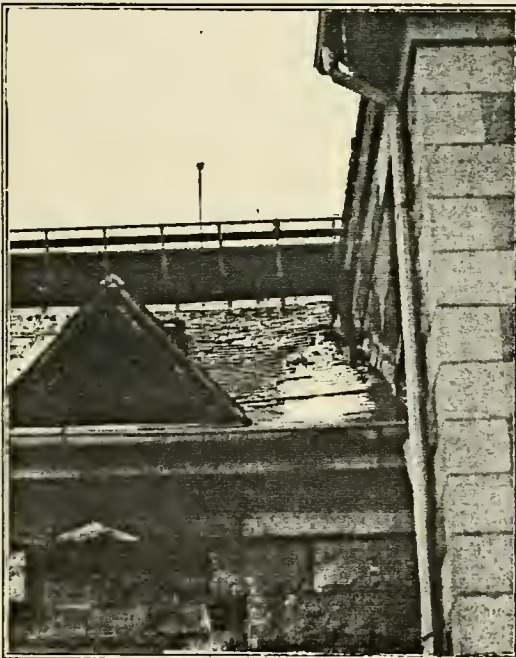
Building 58
Ropewalk Building



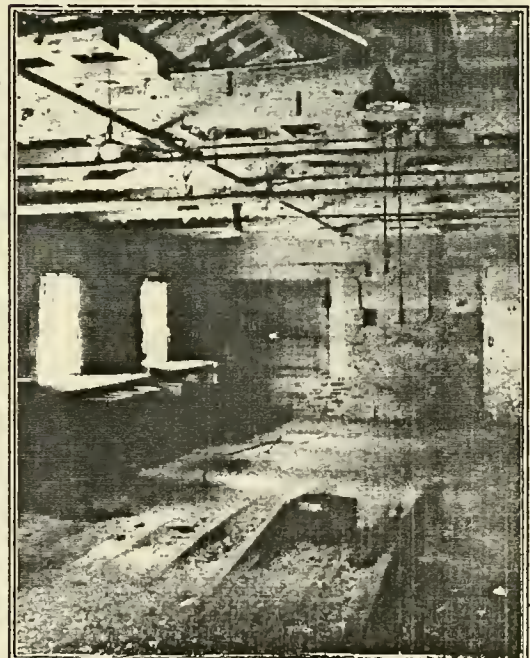
1) Ropewalk interior view



2) Signs of outward movement at top of wall



3) Failed truss in main building by Head House



4) Buckled flooring on 2nd level

Report

to

McGinley Hart & Associates
77 North Washington Street
Boston, Massachusetts 02114

from the

Boston Building Consultants
79 Milk Street
Boston, Massachusetts 02109

on the

Scope of Stabilization Repairs

to

Building 60
Tar House
Charlestown Navy Yard
Boston, Massachusetts

April 2, 1991

B O S T O N
B U I L D I N G
C O N S U L T A N T S

Building 60
Tar House

79 Milk St. Boston MA 02109
6 1 7 / 5 4 2 3 9 3 3

Introduction:

As part of the Boston Redevelopment Authority's (BRA) plans to stabilize Building 60, the Tar House, in the Charlestown Navy Yard and at the request of their architectural consultant, McGinley Hart & Associates (MHA), Boston Building Consultants (BBC) surveyed the structural condition of the Building. BBC understands the BRA plans to repair the building to ensure its structural stability and prevent short-term (10 years) deterioration of its parts. To provide the BRA with a scope of work to ready the building for storage, BBC is reporting on structural damage, its causes, recommendations for repairs, and a corresponding budget.

On February 13, 1991, Arthur Brown and Arthur MacLeod, both of BBC, surveyed the interior and exterior of the main building. On March 5, 1991, Mr. Macleod examined the exterior of the shed at the southwest end.

Building Description:

Located in the northwest area of the Yard, the Tar House is a two-story long but narrow building. Its walls are constructed of granite backed up with brick. The floors and roof are framed with wood. The roof is covered with slate. At the southwest end of the building, a one-story shed adjoins the main building.

Overall Condition and Use:

Inside, the wood framing is coated with hardened tar. In addition, an odor like burnt wood permeates the building. The tar is probably the source of the odor.

In the basement, puddles of water cover the dirt floor. Otherwise the building is dry. The wood and masonry appear to be in good condition

Problem Identification and Evaluation:

At the southwest wall of the shed, the granite wall by the window appears to have been staved in. Some pieces of the exterior granite wythe have moved in about one inch. The stones are about six inches thick and still remain stable. The interior brick wythe appears undamaged.

The main roof has several small holes which allow water to enter. If left unattended, the surrounding wood framing will deteriorate.

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C O N S U L T A N T S

Building 60
Tar House

At the eave of the shed, thrusting forces in the hip beams of the roof framing are pushing out the granite cornice stones. Several stones have moved about one inch. Its not clear when these stones moved. However, if left unchecked, the stones in the top of the wall could be pushed over.

Conclusions:

In general the building is in good structural condition and does not require any major repairs. However, the hip beams in the roof of the shed appears to be slipping.

Recommendations:

Boston Building Consultants recommends that the hip beams be shored from inside the shed and that holes be repaired in the main roof.

The costs for stabilization repairs described above are included in an overall budget which is being prepared separately from this report.

Sincerely,

Arthur H. MacLeod

Building 60
Tar House



1) Tar House interior view

Report

to

McGinley Hart & Associates
77 North Washington Street
Boston, Massachusetts 02114

from the

Boston Building Consultants
79 Milk Street
Boston, Massachusetts 02109

on the

Scope of Stabilization Repairs

to

Building 105
Power House and Forge Shop
Charlestown Navy Yard
Boston, Massachusetts

April 2, 1991

B O S T O N
B U I L D I N G
C O N S U L T A N T S

Building 105

79 Milk St., Boston MA 02109

6 1 7 / 5 4 2 3 9 3 3

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Building 105

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B O S T O N B U I L D I N G C O N S U L T A N T S

Building 105

Introduction:

As part of the Boston Redevelopment Authority's (BRA) plans to stabilize Building 105 in the Charlestown Navy Yard and at the request of their architectural consultant, McGinley Hart & Associates (MHA), Boston Building Consultants (BBC) surveyed the structural condition of the building, reviewed existing drawings, and analyzed major structural elements. BBC understands the BRA plans to repair the building to ensure its structural stability and prevent short-term (10 years) deterioration of its parts. To provide the BRA with a scope of work to ready the building for storage, BBC is reporting on structural damage, its causes (the root of which is water), recommendations for repairs, and a corresponding budget.

In the Fall of 1990, Arthur Brown of BBC briefly surveyed the building. From February 4 to February 13, 1991, Arthur MacLeod assisted by Ken Terani, both of BBC, surveyed the building in detail. During the survey, BBC worked from an aerial lift and the ground inside the Forge Shop and around the entire exterior of Building 105. The Power House and Connector Building interiors were only surveyed from the ground. During this time, Mr. Brown again briefly looked at the building. In addition to a site survey, BBC evaluated the building by reviewing original construction and alteration drawings provided by the BRA through MHA. These drawings are listed in Appendix A. BBC also reviewed MHA survey sketches.

Building Description:

Originally built in 1902, Building 105 is bounded by 1st Avenue on its south face, 2nd Avenue on the north, 9th Street on the west, and 13th Street on the east. Together, the Power House linked to the Forge Shop by the Connector Building make up the entire structure (Fig. 1). Frequent alterations and repairs were made until 1974, when the Navy discontinued its use. During 1943, the Forge Shop was substantially altered.

At the west end of Building 105, the Power House (also once called the Round House), framed with steel columns and hip roof trusses, is enclosed with a double wythe brick wall and a concrete slab roof deck finished with slate tiles. Window arches, dentils under the roof overhang, and a cornice below the dentils are expressed in the brick work. By 1932, the windows along 9th Street were replaced with folding doors. Presently, the doors and windows are covered with gray painted plywood.

Making up more than three-quarters of Building 105, the Forge Shop is framed three bays wide with steel columns and roof trusses. When first built, arch trusses supporting a high roof spanned over the central gallery (photo 1), and mono-pitched trusses supporting low roofs spanned over narrower and symmetrical side galleries. Halfway along the south wall, a gable roof intersects the main roof (photo 2) and frames the main entry.

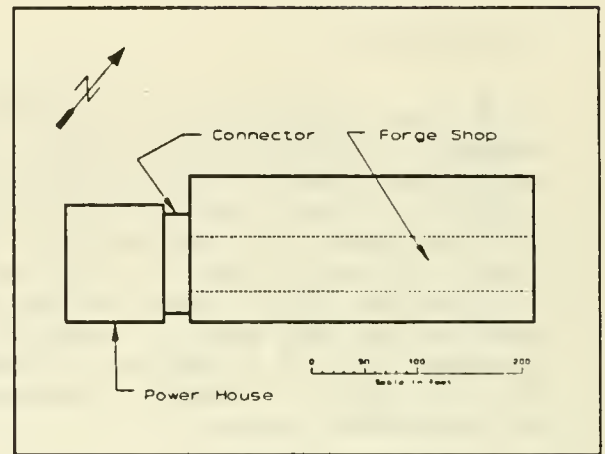


Figure 1 Plan of Building 105

During 1943, the low roofs were raised by relocating north trusses above the south ones which were left in place. New and longer trusses were installed in the north gallery. New steel columns, bearing on the south brick wall, support the trusses at their exterior ends. The north gallery trusses are supported at their exterior ends by full height steel columns.

On top of the central gallery, a monitor clad with corrugated and sheet metal siding runs nearly the full length of the Shop. Ventilators on top of the monitor passively allow air to circulate. Typically, steel beams supported by truss girders carry the roof deck. The monitor roof is decked with 2 inch thick wood; the remainder of the central gallery roof, with bituminously coated corrugated steel deck; the south gallery roof, with 2 inch thick wood; and the north gallery roof, with 2 inch thick metal edged gypsum plank. In the same order, the roof is finished with copper standing seam, the metal deck itself, copper standing seam, and gravel on built-up roofing.

At each end of the central gallery, solid brick walls support the roof ends. Along the south gallery, corrugated cement asbestos siding is attached to steel framing above and below the window of the raised addition. The original brick wall below remains exposed. Along the north gallery, the same type of siding is similarly attached. However, below the siding, the new columns are enclosed with brick. Here, between each pair of columns, is a metal roll-up door. On the south and east walls, the first story windows are covered with gray painted plywood, whereas those in the second story are in many cases open and have broken panes.

The two-story Connector Building, framed with steel beams encased in concrete, is enclosed by a concrete roof deck and brick walls

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Building 105

on its two exposed sides. The roof slopes down north and south from a monitor. The sloped roofs are finished with standing seam metal roofing attached to wood, whereas, the monitor is finished with built-up roofing. Both pitched roofs have skylights. By the south end of the Connector Building, an office mezzanine, accessed from the Forge Shop, once supported a plaster ceiling. Most of the plaster now lies in a heap below.

Some alteration drawings suggest that parts of Building 105 might be supported on pile foundations. Both the Power House and the Forge Shop floors are essentially concrete slabs-on-grade. However, a maze of vaults, tunnels, troughs, pits, and heavy equipment pads spread throughout the building.

The entire building is still filled with machinery and equipment for metal working -- some of which is quite massive. Both the Power House and Forge Shop have overhead cranes mounted on rails.

Overall Condition and Use:

Protecting building materials from water is essential for their preservation. To mention a few reasons, water reacts with oxygen to rust steel, expands when it freezes thereby cracking brick and concrete when trapped, and generates organisms which rot wood. Water is now entering many areas of the building.

A layer of greasy soot covers much of the interior building components. The grease is most noticeable in the Forge Shop, where it has actually helped to protect the steel framing from rusting. The steel is in good condition.

Although a driving rain can pass through the broken second-story windows, these windows provide the only means for light. Electrical power is not available. Also, the broken window panes help to ventilate the space.

Presently, the northwest corner of the Forge Shop is used for storage, including such things as a mast for the USS Constitution and some pallets of brick pavers.

Problem Identification and Evaluation:

Roof: Except in certain areas, the roof of Building 105 is providing adequate protection to meet short-term needs. Problems have been found with the roofing, flashing, decking, monitor siding, skylights, gutters, and downspouts. Most of these problems are in the Forge Shop and the Connector Building. The roof problems are as follows:

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Building 105

1. Copper Standing Seam: In several locations, the copper standing seam roofing is missing. Because the edges of the remaining roofing and flashing are ragged and bent, the roofing appears as if torn off during a storm. Large amounts of water now enter the building in these areas to attack structural elements, especially the wood decking. The main problem locations are as follows:
 - (a) On the north Connector Building pitched roof (photo 3).
 - (b) At each end of the Forge Shop monitor.
 - (c) On the north and south gable cross roofs in the middle of the Forge Shop.
2. Flashing: On the Forge Shop and Connector Building, wherever the standing seam roofing is missing, so is the eave flashing. Water now can enter the once protected walls. Also, in the same building, some cornice flashing has been torn loose by winds. The loose flashing could easily become a dangerous wind-borne missile during a gust.
3. Wood Roof Deck: In a number of areas wood decking is rotting, because the roofing which once protected the deck is missing. The main problem areas are as follows:
 - a. On the gable cross roof in the Forge Shop around covered skylights (photo 4), the deck is severely rotted -- some boards are just hanging by one end and are ready to fall.
 - b. At each end of the Forge Shop monitor, the deck is lightly rotted.
 - c. On the north pitched roof of the Connector Building (photo 3), the deck, fastened to a concrete slab, served as a nailer for the roofing. Now exposed, its ability to adequately hold fasteners has been degraded.
4. Corrugated Metal Deck (photo 6): Over the south gallery, the corrugated decking, punctured by some unknown object, has a one foot wide hole in it. Water can enter and deteriorate surrounding materials.
5. Monitor Siding: At the north side of the gable roof crossing in the Forge Shop and at the Connector Building, the monitor siding is missing. It appears to have blown off. Water can now enter and deteriorate the steel framing and wood substrate of the monitor wall.

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Building 105

6. Skylights:

- a. On the gable cross roof in the Forge Shop, the skylights are covered with plywood. The wood is largely deteriorated. Water can enter through open edges and holes.
- b. On the south sloped roof of the Connector Building, a skylight is missing. In the adjoining monitor, windows are missing. The skylight has a ladder attached to it. It appears to have been used for roof access. Rain water pours into these openings and floods the floors below. The floors and room finishes are highly susceptible to water damage.

7. Gutters and Downspouts (photo 5): At the Power House, many downspouts are missing. Slate roof tiles and sand lie in the gutters. Small holes are starting to appear in the gutter as it corrodes. The ability of this drainage system to protect the brick wall and intricate dentil, cornice, and pier capitals articulated in the brick below has been significantly reduced.

8. Ventilators: From inside the building, the ventilators appear firmly attached to the steel roof framing. From outside, some of the ventilator surfaces are somewhat rusted (because of the danger of walking on a steep slate roof and of stepping on rotting deck elsewhere, the ventilators were only inspected visually). The ventilators are prominently exposed to wind and water making them highly suspect for deterioration. Until they are physically surveyed, their assessment is only speculative.

Masonry Walls: Except for some localized washed out joints in the exterior walls, the flat areas of the outside faces are in good condition. However, at encased steel columns, cornices, and pier capitals the brick is breaking down. These problems are widespread.

1. Power House Piers (photos 8 & 9): At each steel column in the Power House exterior walls, the brick is expressed as a pier wrapped around the column. The pier is set off from the wall by one brick width. The space between the column and the brick is packed tight with mortar. The intent of the packed mortar may have been to provide fire protection to the steel and to stiffen the building against wind loads. However, the mortar acts as a bridge carrying water from the brick thereby rusting the steel. When steel rusts, it expands tenfold. At these piers, the rust is pushing against the mortar which in turn is pushing the brick apart.

In the center of some piers, a crack runs full height to its capital. Cracks in one at the northeast corner and another at the southeast corner are quite wide and unstable. The pier at the southeast corner, cracked on each face, is no longer bonded to the rest of the wall. It could fall over unexpectedly at any time.

Water passes through the brick by absorption, through cracked joints in the brick capitals, and through holes in the gutters. Because of absorption, the source of water cannot be completely cut off. Therefore, patching these cracks is a short-term repair. In time the cracks will reappear. These piers have been previously patched. A long-term repair would have to deal with the packed mortar around the columns.

2. Holes in Walls: A number of holes in the Power House walls, left after utility pipes were removed, allow water to enter the wall. Some of these holes are up near the roof. Because the bricks at the edge of the hole are exposed and not solidly bonded together, they could fall when loosened from weathering. In the Power House at the south face, brick is broken (perhaps struck) at a former window filled in with brick.
3. Cornice Brickwork (photos 10 & 11): In the cornice brickwork around the Power House and some of the taller brick walls of the Forge Shop, the top course, which forms a shelf one brick wide, is laid with headers alternating with stretchers. The result is that the stretcher units are not interlocked with the wall. In many cases, the stretchers only rest on a broken mortar bed. At one time on top of the shelf, a 1/2 inch thick mortar wash provided some measure of water protection. Most of the wash is now gone. Presently, water can enter through the joint between the wall and the stretchers. Also, some of the now loose stretchers have moved outward and could fall during a gust.
4. Pier Capital Brickwork (photo 10): At the Power House piers and some Forge Shop piers, The top course -- a header course -- forms a shelf one brick length wide. A former 1/2 inch thick mortar wash on the shelf once provided some measure of water protection. Most of the wash is now gone. Presently, water enters into the pier through the cracked mortar joints. Many of these bricks have shifted sideways and are ready to topple.
5. Dentil and Cornice Corners (photo 12): At all protruding building and pier corners where a cornice or dentil is expressed, the bricks that bolster the work are themselves supported by slate or sheet metal pieces wedged into the masonry joints. Where these pieces are made of metal, they

are corroded. In most cases the cornice and dentils are sagging under their own weight. They could collapse at any time and fall to the sidewalks below.

Steel Column Bases: In the Forge Shop, some of the columns along the central gallery have base and stiffener plates fashioned so that they inadvertently hold water. As these pockets of water dry out and refill, they locally rust the steel.

Miscellaneous Safety Hazards: Besides deteriorating main structural materials, water is attacking secondary materials. These failures result from the breakdown of the primary ones.

1. **Connector Building Ceiling:** The first floor ceiling in the south part of the Connector Building has recently collapsed. During his survey in the Fall of 1990, Mr. Brown saw that the ceiling was intact. Between then and the February 1991 survey, it failed. Other ceilings in this area are probably weak and ready to fall. The cause of the failure is water flooding the floors above from the open skylight above them.
2. **Power House Exterior Light Bracket:** At the northwest corner of the Power House up near the roof, an anchor bolt supporting a light fixture has broken free of the brick. The remaining anchorages are now overstressed and the fixture could fall off at anytime. Water entering in the hole from abandoned pipe penetration weakened the brick holding the anchors.

Structural Analysis:

As part of the assessment of Building 105, several standard structural elements were analytically examined. After evaluating the steel (beam) purlins, wood decking, gypsum plank, and a steel truss girder in the Forge Shop north gallery, the roof capacity is more than adequate for current code design loads. The roof could carry heavier roof finishes.

The columns on each side of the center gallery carry the roof as well as loads from an overhead crane. These loads only moderately stress the columns. Because the columns are large and knee bracing connects to the truss girders, It is clear that the columns also resist lateral loads.

The Power House piers, built tight to the steel columns, appear to resist lateral loading. Any permanent repairs to these piers must take into consideration their lateral load resistance capacity.

Conclusions:

Slowly but steadily, water, is breaking down materials in the building. As parts of the building weaken, they present a danger to passersby (falling brick or windblown roofing) and to personnel working inside (storing materials). In addition to public safety, the material and historical value of the building is endangered.

By making short-term stabilization repairs, the immediate danger can be eliminated and deterioration arrested. The short-term repairs should eliminate most but not necessarily all sources of water entry. For example, leaving vertical windows uncovered would provide daylight illumination (and desirable ventilation). However, rain could still enter through broken panes. The tradeoff is between walking in the dark around many dangerous holes in the floor and keeping materials dry which are not highly susceptible to rapid deterioration. The greasy soot is providing a measure of short-term protection to interior building materials.

Recommendations:

To adequately stabilize the building, BBC recommends making short-term repairs to the structure and finishes described in the problem identification section of this report. Areas of the roof and masonry walls require the following repairs.

1. Repair the roof by replacing missing or deteriorated roofing, flashing, and decking. All wood decking where roofing is missing is deteriorated.
2. Replace missing monitor siding.
3. Cover all open skylights. Replace deteriorated covers.
4. Line the Power House gutters with neoprene.
5. Rebuild loose bricks at the top course of the pier capitals.
6. Rebuild loose bricks at the top course of the cornices.
7. Rebuild loose bricks that bolster prominent corners of dentils, cornices, and pier capitals. Replace corroded sheet metal and broken slates wedged in the joints.
8. Cover or plug holes in brick walls.
9. Restore mortar washes over cornices and capitals.

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Building 105

10. Repoint local areas in brick wall where mortar has eroded to a depth of greater than 1 inch.
11. Drill weep holes to drain trapped water at interior steel column bases.
12. When roof repairs are made, the ventilators should be physically inspected. They may require repair and stabilization.

For public safety, the following precautions should be undertaken:

1. In the Power House at the cracked piers, one at the southeast corner and another at the northeast corner, tear down and rebuild the brick to U.S. Department of Interior standards or install temporary stainless steel strapping and caulk all cracks.
2. Because of the loose cornice, dentil, and pier capital brick, cordon off the adjoining sidewalks to Building 105 until stabilization repairs are complete.
3. Since the Connector House framing and finishes are in an advanced state of deterioration, cordon off this area inside the building (people still enter to store and retrieve materials).
4. Broken and deteriorated windows sashes on the north side of the Forge Building should be removed or nailed shut.

The costs for stabilization repairs described above are included in an overall budget which is being prepared separately from this report.

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Appendix A:
Drawings Reviewed
Building 105

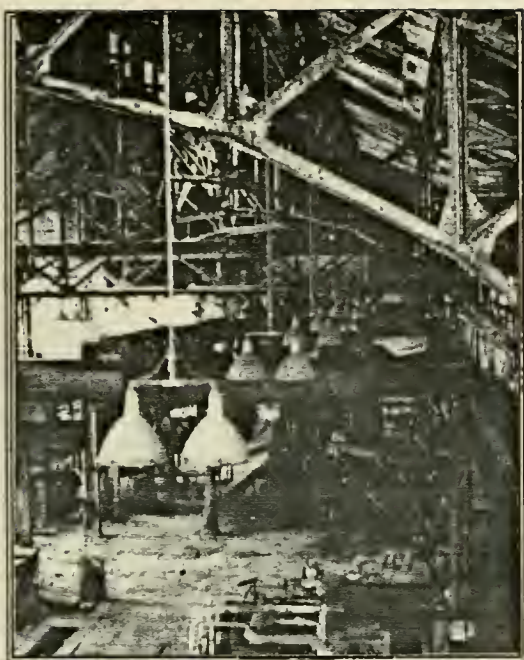
List of Drawings

<u>Drawing #</u>	<u>Date</u>	<u>Title</u>
D365 (105 sh 9)	Jan 23, 1901	Building No. 105 C. & R. - Power House at West End of Smithery - Framing Plans and Details of Truss A.
D366 (105 sh 10)	Dec 10, 1900	Building No. 105 C. & R. - Power House at West End of Smithery. Details of Truss B.
D367 (105 sh 11)	Dec 10, 1900	Building No. 105 C. & R. - Power House at West End of Smithery. - Details of columns.
A526	Mar 1902	Building No. 105 - Smithery for Dep't. of C. & R. - Longitudinal Section through Connecting Building between Power House & Smithery.
A529	Mar 22, 1902	Building No. 105 - Smithery for Dep't. of C. and R. Half Sections of N.E. & S.W. Ends.
105-148	Sep 15, 1943 R	Building 105 - North Extension- Side and End Walls - Steel Framing.
105-149	Oct 12, 1943 R	Building 105 - South Extension - Roof and Side Walls - Steel Framing.
105-153	Aug 19, 1943	Building 105 - North and South Extensions - North Elevation & Exterior Doors.
105-154	Sep 24, 1943 R	Building 105 - North and South Extensions - South, East & West Elevations.
105-155	Sep 24, 1943 R	Building 105 - North & South Extensions - Sections and Exterior Details.
105-167	Apr 6, 1944	Building 105 - First, Second, & Mezzanine Floor Plans.

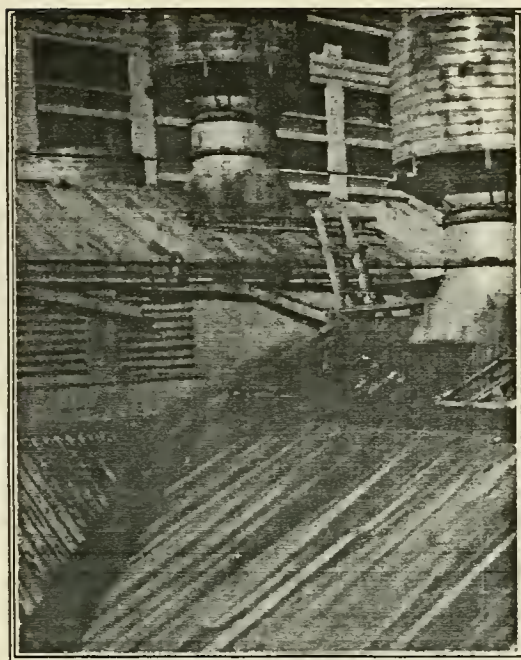
B O S T O N
B U I L D I N G
C O N S U L T A N T S

Appendix A:
Drawings Reviewed
Building 105

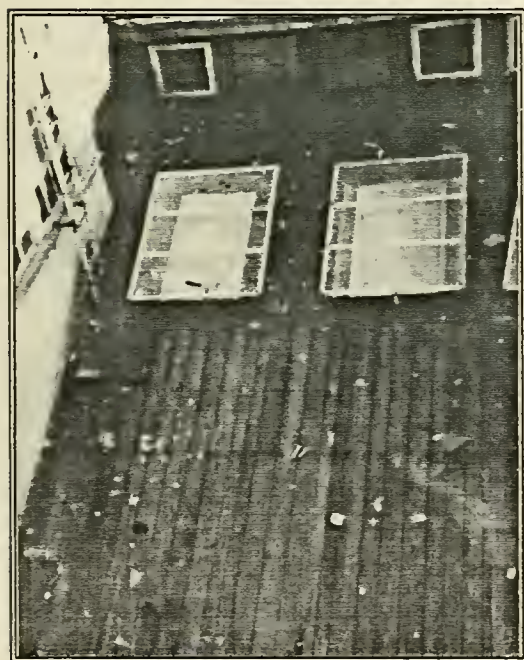
105-173	Jul 27, 1945	Building 105 - Dormers - Round House Roof.
105-178	Jun 26, 1947	Bldg. 105 - Repairs to Roof
105-235	Jun 6, 1952	Chain Shop - Building No. 105 - Ventilation Details.
105-265	Aug 6, 1964	Building 105 - Roundhouse and Forge Shop Annex Roof Repairs - Plans, Elev., Sect., and Detail - Architectural - and Structural.
21126	Oct 8, 1965	Forge Shop Building No. 105 - Arrangement of Equipment.



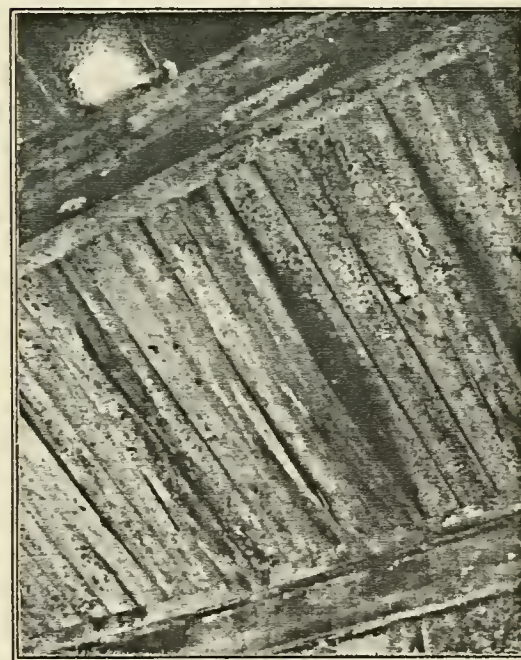
1) The central gallery of
the Forge Shop



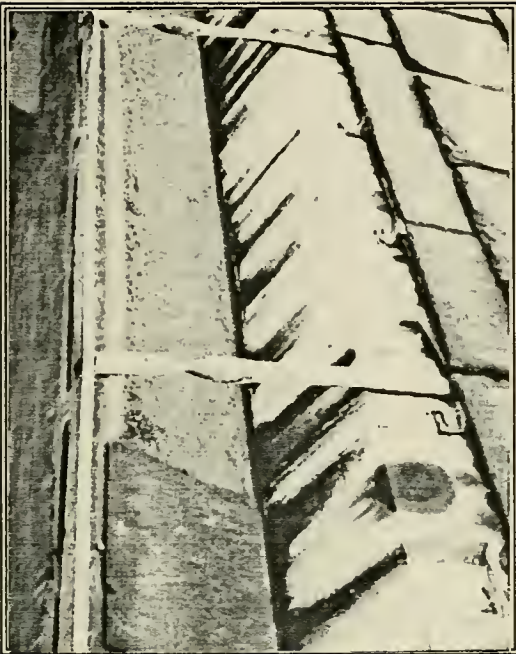
2) Forge Shop roof
intersection



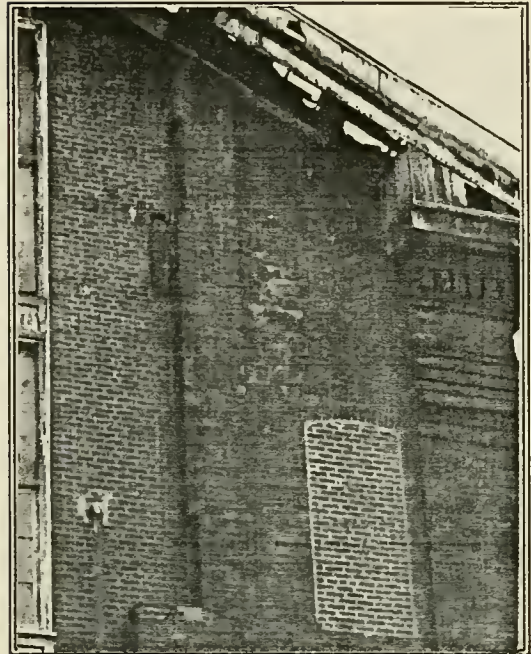
3) Connector building roof



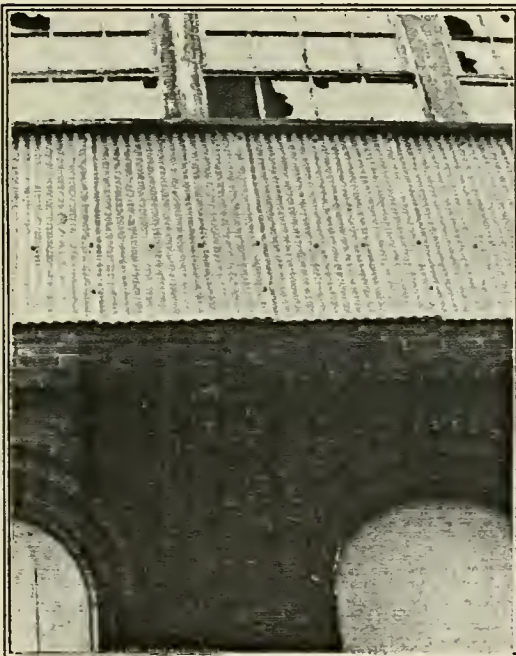
4) Interior view of wood
roof deck in the Forge Shop



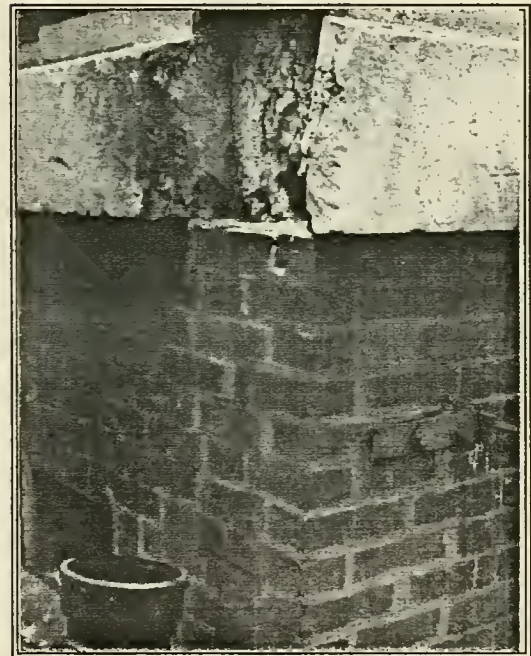
5) Power House gutter



6) South entry of the Forge Shop



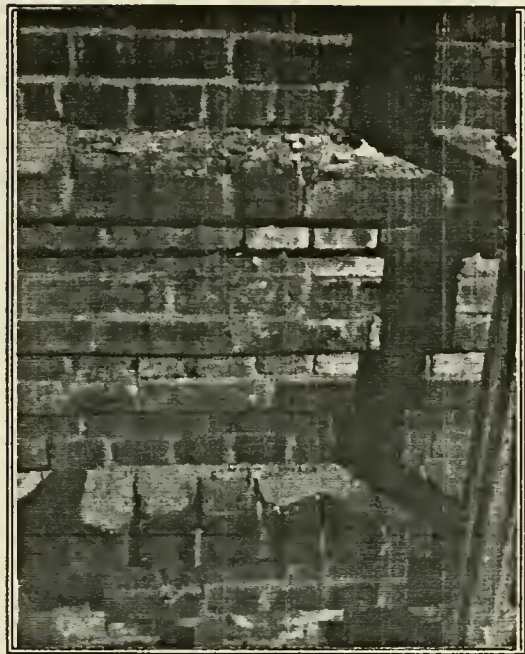
7) Pier at south wall of
the Forge Shop



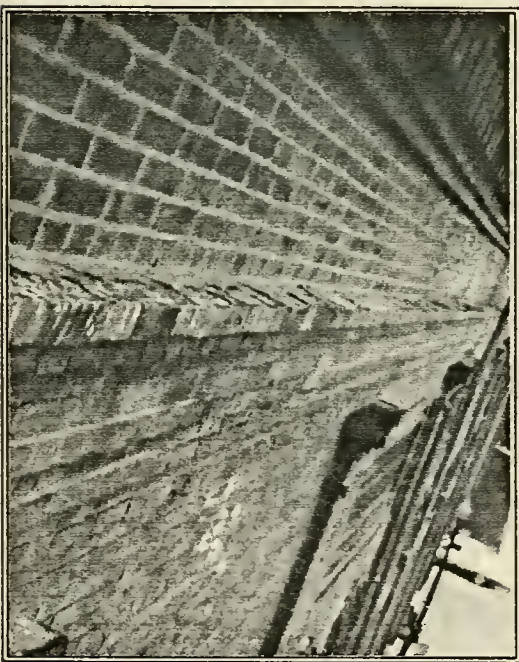
8) Cracks and old repairs
in Power House masonry



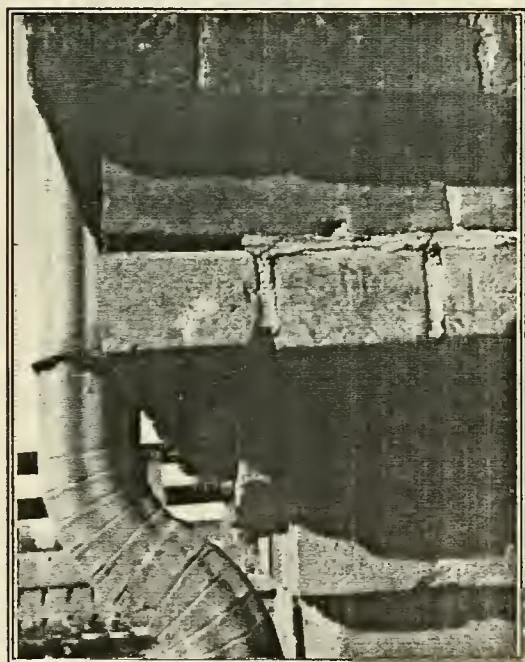
9) Mortar packed tightly
between steel and masonry



10) Loose bricks at pier
capitals and cornice



11) Broken wash on cornice
and pier capitals



12) Makeshift sheet metal
and slate supports at brick
corners

LOCATION MAP

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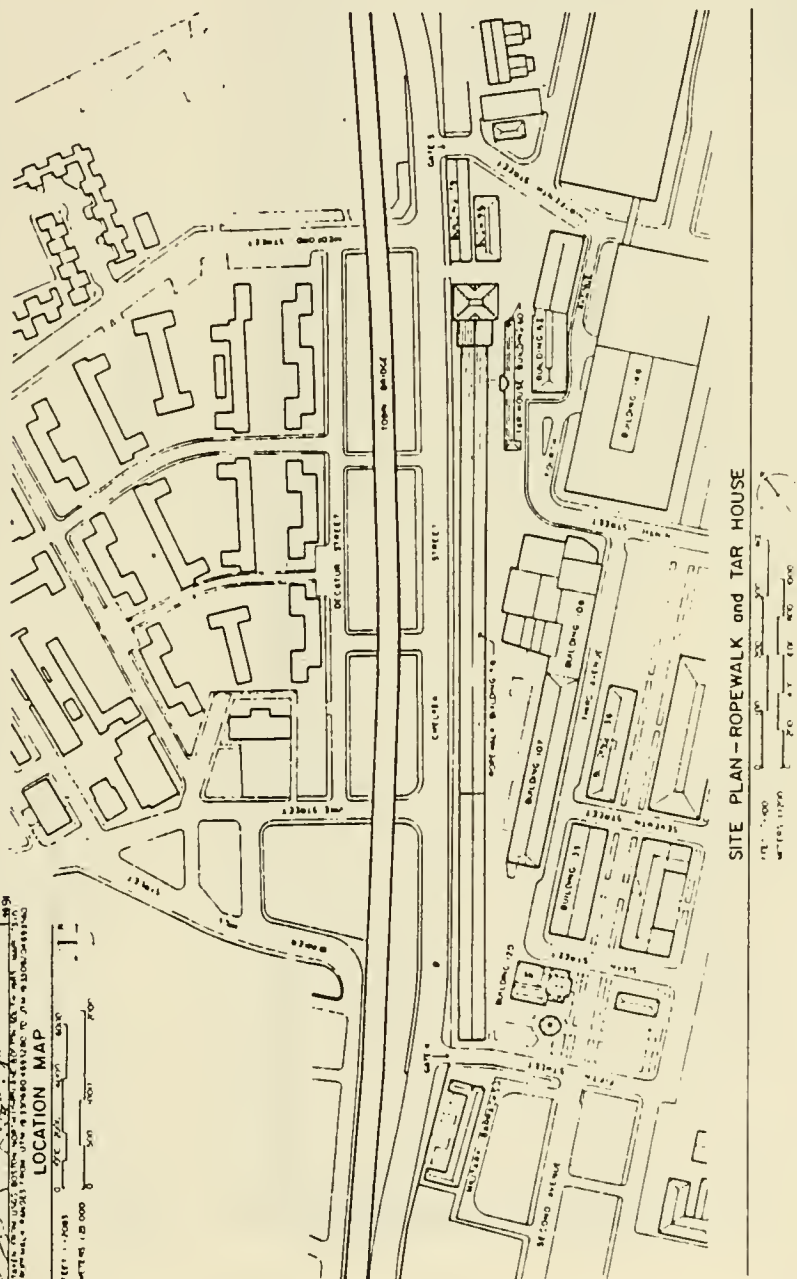
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THE ROPEWALK BUILDING 589 AND THE TAR HOUSE BUILDING 606 WERE THE PRINCIPAL STRUCTURES IN THE CHARLESTON NAVY YARD ROPE MANUFACTURING COMPLEX. FROM 1838 TO 1970 MOST OF THE CONGRAD FOR THE UNITED STATES NAVY'S SHIPS WAS PRODUCED IN THESE BUILDINGS. THE ROPEWALK IS THE ONLY BUILDING OF ITS TYPE IN THE NATION WHICH WAS NOT BEING SIGNIFICANTLY ALTERED OR MOVED FROM ITS ORIGINAL SITE. THE TAR HOUSE IS ONE OF THE LEAST CHANGED BUILDINGS IN THE NAVY YARD

THE GRANITE FACED BRICK BUILDINGS WERE CONSTRUCTED FROM THE PLANS OF ALEXANDER PARRIS, BETWEEN 1834 AND 1838. PARRIS, A LEADING ARCHITECT OF THAT ERA, IS BEST KNOWN FOR HIS DESIGN OF THE QUINCY MARKETPLACE, AND FOR HIS ROLE AS CHIEF ARCHITECT OF THE NAVY YARD (FROM 1823 TO THE 1840S).

ROPE, UP TO A QUARTER OF A MILE LONG, COULD BE MANUFACTURED INSIDE THE 1323-FOOT-LONG BY 43-FOOT-WIDE ROPEWALK. DANIEL TREADWELL, AN ENGINEER AND INVENTOR DEVELOPED THE INNOVATIVE MACHINERY, ENGINES, AND BOILERS FOR THE MOSTLY TWO STORY BUILDINGS.

THE BOSTON REDEVELOPMENT AUTHORITY ACQUIRED THE ROPEWALK AND TAR HOUSE IN 1973, WHEN THE UNITED STATES NAVY CLOSED THE CHARLESTOWN NAVY YARD

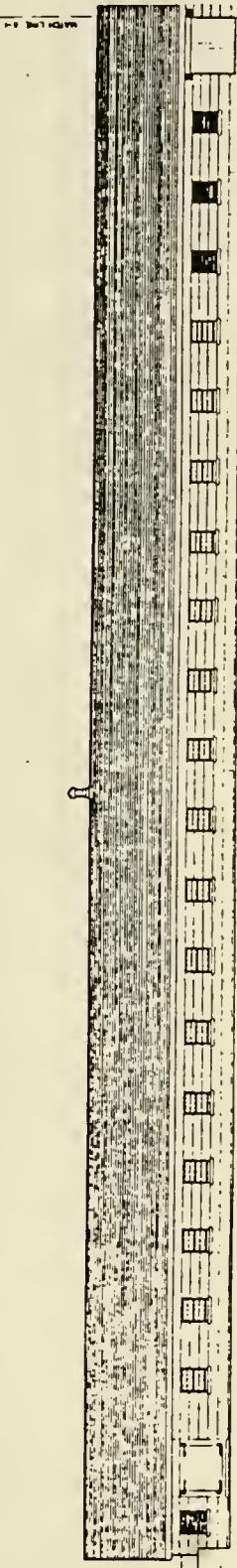
THIS PROJECT WAS UNDERTAKEN BY THE HISTORIC PRESERVATION DIVISION OF THE U.S. DEPARTMENT OF THE INTERIOR. THE PROJECT TEAM INCLUDED AMERICAN BUILDINGS SURVEY, HARSHBARGER, HARRIS AND ASSOCIATES, INC., THE NATIONAL HISTORIC PRESERVATION CENTER, IT WAS EXECUTED UNDER THE DIRECTION OF ROBERT J. KAPSCHE, CHIEF OF HARSHBARGER, AND PAUL O. OLMESKY, PRINCIPAL ARCHITECT. STEPHEN SCHREIBER, UNIVERSITY OF TEXAS ARCHITECT, AND ARCHITECTURAL TECHNICIANS M. MARISTH ANDRES (BOSTON) AND DANIEL AND NORTH TEXAS A&T STATE UNIVERSITY, DOCUMENTATION WAS COMPLETED DURING THE SUMMER OF 1989.



1. 3. 4. 5. 6. 7. 8. 9. 10. 11. 12. 13. 14. 15. 16. 17. 18. 19. 20. 21. 22. 23. 24. 25. 26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. 37. 38. 39. 40. 41. 42. 43. 44. 45. 46. 47. 48. 49. 50. 51. 52. 53. 54. 55. 56. 57. 58. 59. 60. 61. 62. 63. 64. 65. 66. 67. 68. 69. 70. 71. 72. 73. 74. 75. 76. 77. 78. 79. 80. 81. 82. 83. 84. 85. 86. 87. 88. 89. 90. 91. 92. 93. 94. 95. 96. 97. 98. 99. 100. 101. 102. 103. 104. 105. 106. 107. 108. 109. 110. 111. 112. 113. 114. 115. 116. 117. 118. 119. 120. 121. 122. 123. 124. 125. 126. 127. 128. 129. 130. 131. 132. 133. 134. 135. 136. 137. 138. 139. 140. 141. 142. 143. 144. 145. 146. 147. 148. 149. 150. 151. 152. 153. 154. 155. 156. 157. 158. 159. 160. 161. 162. 163. 164. 165. 166. 167. 168. 169. 170. 171. 172. 173. 174. 175. 176. 177. 178. 179. 180. 181. 182. 183. 184. 185. 186. 187. 188. 189. 190. 191. 192. 193. 194. 195. 196. 197. 198. 199. 200. 201. 202. 203. 204. 205. 206. 207. 208. 209. 210. 211. 212. 213. 214. 215. 216. 217. 218. 219. 220. 221. 222. 223. 224. 225. 226. 227. 228. 229. 230. 231. 232. 233. 234. 235. 236. 237. 238. 239. 240. 241. 242. 243. 244. 245. 246. 247. 248. 249. 250. 251. 252. 253. 254. 255. 256. 257. 258. 259. 260. 261. 262. 263. 264. 265. 266. 267. 268. 269. 270. 271. 272. 273. 274. 275. 276. 277. 278. 279. 280. 281. 282. 283. 284. 285. 286. 287. 288. 289. 290. 291. 292. 293. 294. 295. 296. 297. 298. 299. 300. 301. 302. 303. 304. 305. 306. 307. 308. 309. 310. 311. 312. 313. 314. 315. 316. 317. 318. 319. 320. 321. 322. 323. 324. 325. 326. 327. 328. 329. 330. 331. 332. 333. 334. 335. 336. 337. 338. 339. 340. 341. 342. 343. 344. 345. 346. 347. 348. 349. 350. 351. 352. 353. 354. 355. 356. 357. 358. 359. 360. 361. 362. 363. 364. 365. 366. 367. 368. 369. 370. 371. 372. 373. 374. 375. 376. 377. 378. 379. 380. 381. 382. 383. 384. 385. 386. 387. 388. 389. 390. 391. 392. 393. 394. 395. 396. 397. 398. 399. 400. 401. 402. 403. 404. 405. 406. 407. 408. 409. 410. 411. 412. 413. 414. 415. 416. 417. 418. 419. 420. 421. 422. 423. 424. 425. 426. 427. 428. 429. 430. 431. 432. 433. 434. 435. 436. 437. 438. 439. 440. 441. 442. 443. 444. 445. 446. 447. 448. 449. 450. 451. 452. 453. 454. 455. 456. 457. 458. 459. 460. 461. 462. 463. 464. 465. 466. 467. 468. 469. 470. 471. 472. 473. 474. 475. 476. 477. 478. 479. 480. 481. 482. 483. 484. 485. 486. 487. 488. 489. 490. 491. 492. 493. 494. 495. 496. 497. 498. 499. 500. 501. 502. 503. 504. 505. 506. 507. 508. 509. 510. 511. 512. 513. 514. 515. 516. 517. 518. 519. 520. 521. 522. 523. 524. 525. 526. 527. 528. 529. 530. 531. 532. 533. 534. 535. 536. 537. 538. 539. 540. 541. 542. 543. 544. 545. 546. 547. 548. 549. 550. 551. 552. 553. 554. 555. 556. 557. 558. 559. 560. 561. 562. 563. 564. 565. 566. 567. 568. 569. 570. 571. 572. 573. 574. 575. 576. 577. 578. 579. 580. 581. 582. 583. 584. 585. 586. 587. 588. 589. 590. 591. 592. 593. 594. 595. 596. 597. 598. 599. 600. 601. 602. 603. 604. 605. 606. 607. 608. 609. 610. 611. 612. 613. 614. 615. 616. 617. 618. 619. 620. 621. 622. 623. 624. 625. 626. 627. 628. 629. 630. 631. 632. 633. 634. 635. 636. 637. 638. 639. 640. 641. 642. 643. 644. 645. 646. 647. 648. 649. 650. 651. 652. 653. 654. 655. 656. 657. 658. 659. 660. 661. 662. 663. 664. 665. 666. 667. 668. 669. 670. 671. 672. 673. 674. 675. 676. 677. 678. 679. 680. 681. 682. 683. 684. 685. 686. 687. 688. 689. 690. 691. 692. 693. 694. 695. 696. 697. 698. 699. 700. 701. 702. 703. 704. 705. 706. 707. 708. 709. 710. 711. 712. 713. 714. 715. 716. 717. 718. 719. 720. 721. 722. 723. 724. 725. 726. 727. 728. 729. 730. 731. 732. 733. 734. 735. 736. 737. 738. 739. 740. 741. 742. 743. 744. 745. 746. 747. 748. 749. 750. 751. 752. 753. 754. 755. 756. 757. 758. 759. 760. 761. 762. 763. 764. 765. 766. 767. 768. 769. 770. 771. 772. 773. 774. 775. 776. 777. 778. 779. 780. 781. 782. 783. 784. 785. 786. 787. 788. 789. 790. 791. 792. 793. 794. 795. 796. 797. 798. 799. 800. 801. 802. 803. 804. 805. 806. 807. 808. 809. 810. 811. 812. 813. 814. 815. 816. 817. 818. 819. 820. 821. 822. 823. 824. 825. 826. 827. 828. 829. 830. 831. 832. 833. 834. 835. 836. 837. 838. 839. 840. 841.

PARTIAL FIRST FLOOR PLAN - ROPEWALK

PARTIAL SOUTHEAST ELEVATION-ROPEWALK



PARTIAL FIRST FLOOR PLAN - ROPEWALK

1911 1912 1913 1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928 1929 1930 1931 1932 1933 1934 1935 1936 1937 1938 1939 1940 1941 1942 1943 1944 1945 1946 1947 1948 1949 1950 1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040 2041 2042 2043 2044 2045 2046 2047 2048 2049 2050 2051 2052 2053 2054 2055 2056 2057 2058 2059 2060 2061 2062 2063 2064 2065 2066 2067 2068 2069 2070 2071 2072 2073 2074 2075 2076 2077 2078 2079 2080 2081 2082 2083 2084 2085 2086 2087 2088 2089 2090 2091 2092 2093 2094 2095 2096 2097 2098 2099 2100 2101 2102 2103 2104 2105 2106 2107 2108 2109 2110 2111 2112 2113 2114 2115 2116 2117 2118 2119 2120 2121 2122 2123 2124 2125 2126 2127 2128 2129 2130 2131 2132 2133 2134 2135 2136 2137 2138 2139 2140 2141 2142 2143 2144 2145 2146 2147 2148 2149 2150 2151 2152 2153 2154 2155 2156 2157 2158 2159 2160 2161 2162 2163 2164 2165 2166 2167 2168 2169 2170 2171 2172 2173 2174 2175 2176 2177 2178 2179 2180 2181 2182 2183 2184 2185 2186 2187 2188 2189 2190 2191 2192 2193 2194 2195 2196 2197 2198 2199 2200 2201 2202 2203 2204 2205 2206 2207 2208 2209 2210 2211 2212 2213 2214 2215 2216 2217 2218 2219 2220 2221 2222 2223 2224 2225 2226 2227 2228 2229 2230 2231 2232 2233 2234 2235 2236 2237 2238 2239 2240 2241 2242 2243 2244 2245 2246 2247 2248 2249 2250 2251 2252 2253 2254 2255 2256 2257 2258 2259 2260 2261 2262 2263 2264 2265 2266 2267 2268 2269 2270 2271 2272 2273 2274 2275 2276 2277 2278 2279 2280 2281 2282 2283 2284 2285 2286 2287 2288 2289 2290 2291 2292 2293 2294 2295 2296 2297 2298 2299 2300 2301 2302 2303 2304 2305 2306 2307 2308 2309 2310 2311 2312 2313 2314 2315 2316 2317 2318 2319 2320 2321 2322 2323 2324 2325 2326 2327 2328 2329 2330 2331 2332 2333 2334 2335 2336 2337 2338 2339 2340 2341 2342 2343 2344 2345 2346 2347 2348 2349 2350 2351 2352 2353 2354 2355 2356 2357 2358 2359 2360 2361 2362 2363 2364 2365 2366 2367 2368 2369 2370 2371 2372 2373 2374 2375 2376 2377 2378 2379 2380 2381 2382 2383 2384 2385 2386 2387 2388 2389 2390 2391 2392 2393 2394 2395 2396 2397 2398 2399 2400 2401 2402 2403 2404 2405 2406 2407 2408 2409 2410 2411 2412 2413 2414 2415 2416 2417 2418 2419 2420 2421 2422 2423 2424 2425 2426 2427 2428 2429 2430 2431 2432 2433 2434 2435 2436 2437 2438 2439 2440 2441 2442 2443 2444 2445 2446 2447 2448 2449 2450 2451 2452 2453 2454 2455 2456 2457 2458 2459 2460 2461 2462 2463 2464 2465 2466 2467 2468 2469 2470 2471 2472 2473 2474 2475 2476 2477 2478 2479 2480 2481 2482 2483 2484 2485 2486 2487 2488 2489 2490 2491 2492 2493 2494 2495 2496 2497 2498 2499 2500 2501 2502 2503 2504 2505 2506 2507 2508 2509 2510 2511 2512 2513 2514 2515 2516 2517 2518 2519 2520 2521 2522 2523 2524 2525 2526 2527 2528 2529 2530 2531 2532 2533 2534 2535 2536 2537 2538 2539 2540 2541 2542 2543 2544 2545 2546 2547 2548 2549 2550 2551 2552 2553 2554 2555 2556 2557 2558 2559 2560 2561 2562 2563 2564 2565 2566 2567 2568 2569 2570 2571 2572 2573 2574 2575 2576 2577 2578 2579 2580 2581 2582 2583 2584 2585 2586 2587 2588 2589 2590 2591 2592 2593 2594 2595 2596 2597 2598 2599 2600 2601 2602 2603 2604 2605 2606 2607 2608 2609 2610 2611 2612 2613 2614 2615 2616 2617 2618 2619 2620 2621 2622 2623 2624 2625 2626 2627 2628 2629 2630 2631 2632 2633 2634 2635 2636 2637 2638 2639 2640 2641 2642 2643 2644 2645 2646 2647 2648 2649 2650 2651 2652 2653 2654 2655 2656 2657 2658 2659 2660 2661 2662 2663 2664 2665 2666 2667 2668 2669 2670 2671 2672 2673 2674 2675 2676 2677 2678 2679 2680 2681 2682 2683 2684 2685 2686 2687 2688 2689 2690 2691 2692 2693 2694 2695 2696 2697 2698 2699 2700 2701 2702 2703 2704 2705 2706 2707 2708 2709 2710 2711 2712 2713 2714 2715 2716 2717 2718 2719 2720 2721 2722 2723 2724 2725 2726 2727 2728 2729

STATION WALLS GREENFIELD BRICK
STATION WALLS GREENFIELD BRICK

0.023

070908

ROPEWALK and TAR HOUSE

BLUDD 30 and BLUDD 34, CHALISTON, SOUTH CAROLINA, 1907. SOUTH CAROLINA COUNTY MASSACHUSETTS

1907 A
1907 B
1907 C
1907 D
1907 E
1907 F
1907 G
1907 H
1907 I
1907 J
1907 K
1907 L
1907 M
1907 N
1907 O
1907 P
1907 Q
1907 R
1907 S
1907 T
1907 U
1907 V
1907 W
1907 X
1907 Y
1907 Z

ROPEWALK and TAR HOUSE
CHALISTON, SOUTH CAROLINA
1907 A
1907 B
1907 C
1907 D
1907 E
1907 F
1907 G
1907 H
1907 I
1907 J
1907 K
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1907 Z

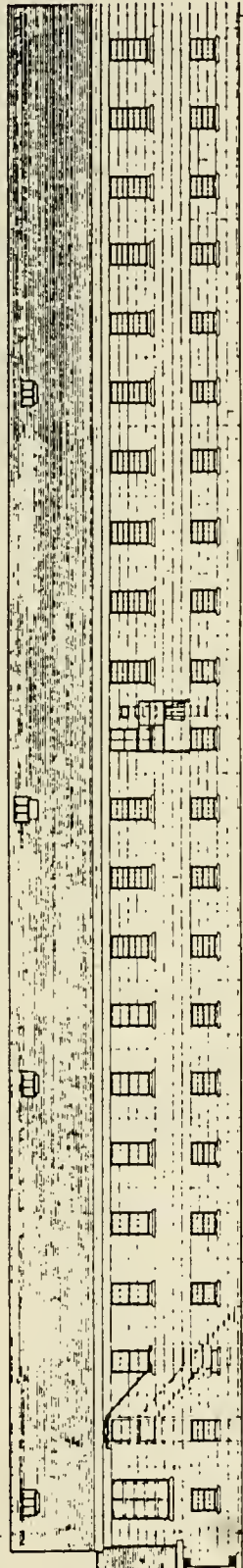


WEST WALL
EXTERIOR WALLS GRANITE FACED BRICK
5.00" CONCRETE SLAB
ROOF SLATE TILES

PARTIAL FIRST FLOOR PLAN-ROPEWALK
1/4" = 1'-0"

PARTIAL SOUTHEAST ELEVATION-ROPEWALK

20' 0"



MATCH LINE C-4

MATCH LINE B-4

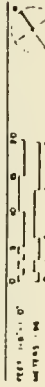
ROPEWALK and TAR HOUSE

ROPEWALK and TAR HOUSE
 1948
 1948
 1948



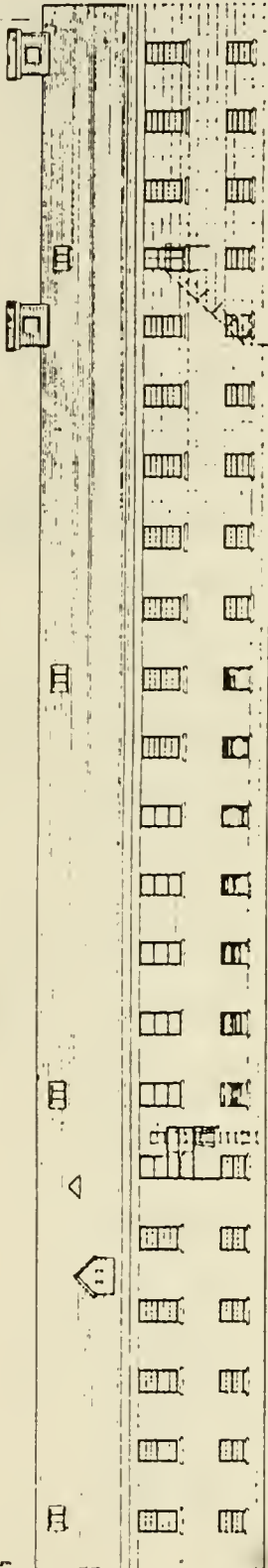
WATER LINE 0'-1"
 MATERIALS
 EXTERIOR WALLS GRANITE FACED BRICK
 BRICK WELL
 FLOOR CONCRETE SLAB
 ROOF SLATE TILES

PARTIAL FIRST FLOOR PLAN - ROPEWALK



PARTIAL SOUTHEAST ELEVATION - ROPEWALK

SEE 0'-1"
 MATERIALS
 EXTERIOR WALLS GRANITE FACED BRICK
 BRICK WELL
 FLOOR CONCRETE SLAB
 ROOF SLATE TILES



ROPEWALK and TAR HOUSE

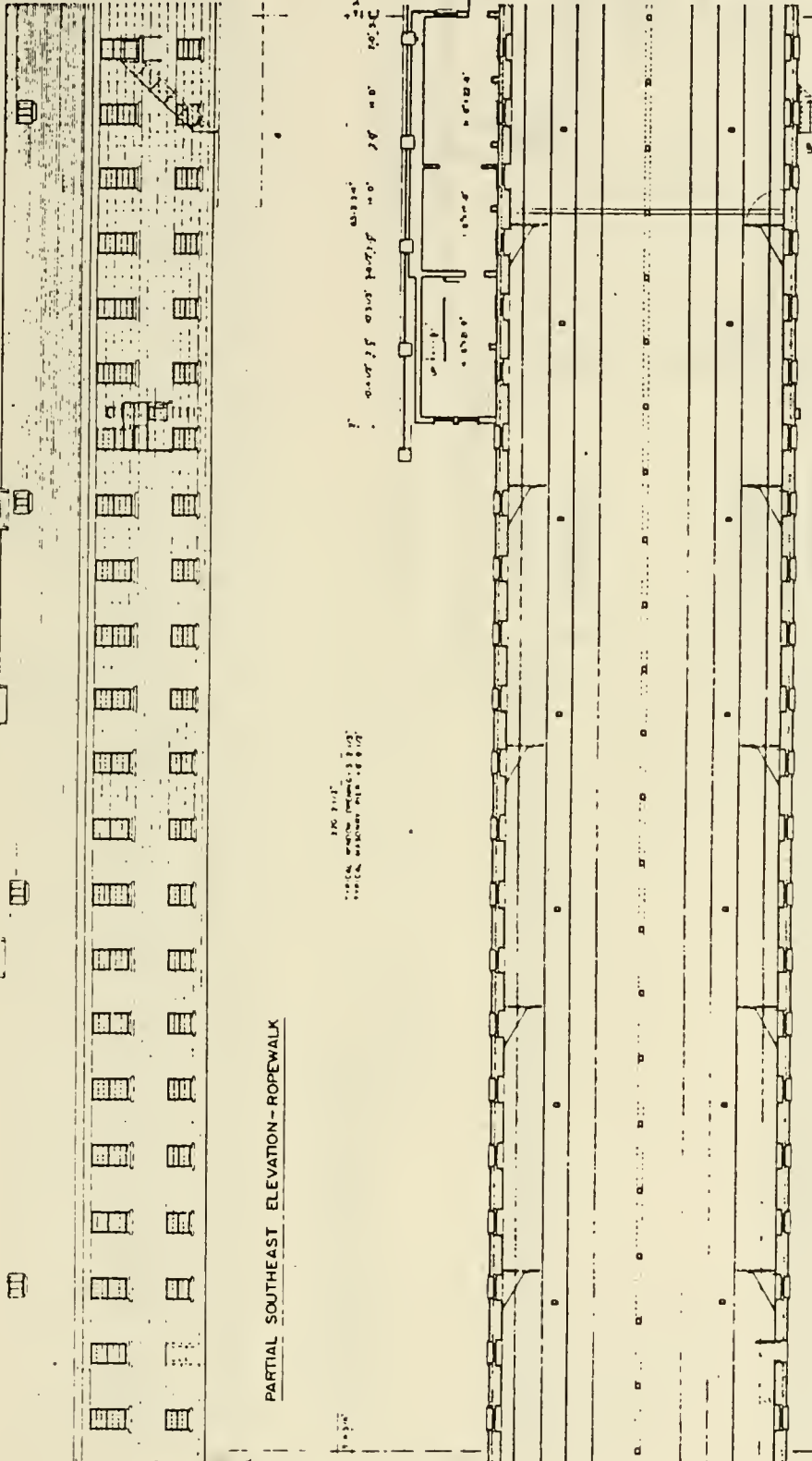
PARTIAL SOUTHEAST ELEVATION - ROPEWALK

PARTIAL FIRST FLOOR PLAN - ROPEWALK

MATERIALS
 EXTERIOR WALLS GRAY'S FACED BRICK
 BRICK ADDITION
 FLOOR CONCRETE SLAB
 WOOD PLANKING
 ROOF SLATE TILES

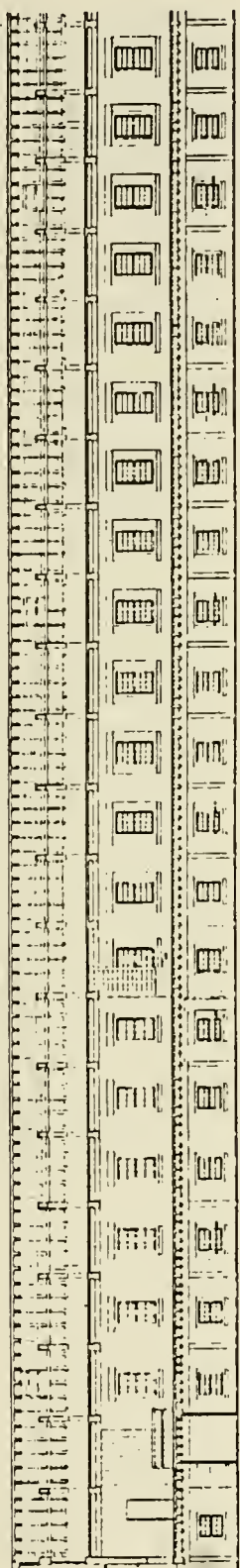
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 170' 11 1/2"
 170' 11 1/2"

170' 11 1/2"
 170' 11 1/2"
 170' 11 1/2"

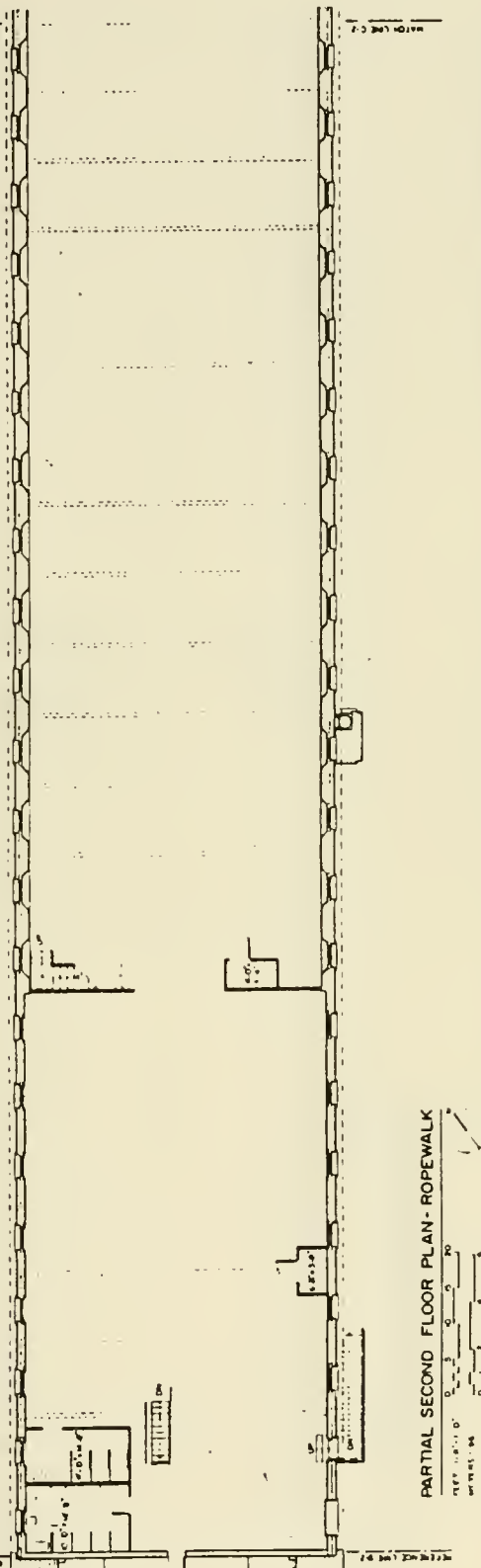




PARTIAL LONGITUDINAL SECTION - ROPEWALK



PARTIAL SECOND FLOOR PLAN - ROPEWALK



ROPEWALK and TAR HOUSE

PARTIAL LONGITUDINAL SECTION—ROPEWALK

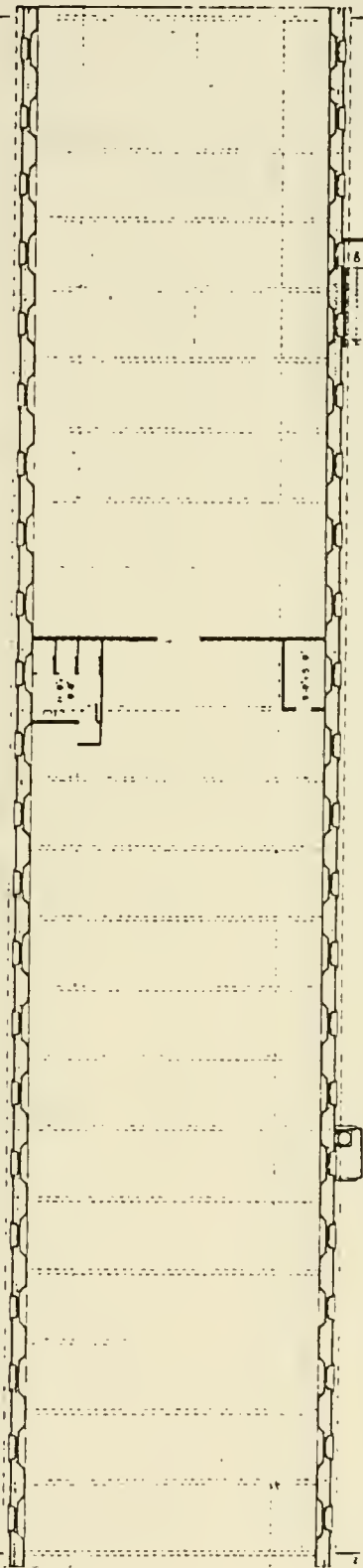
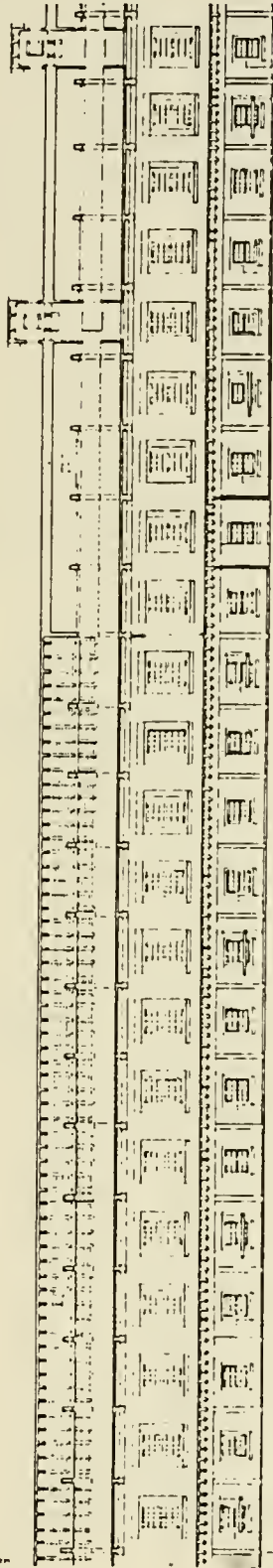
A-A

PARTIAL SECOND FLOOR PLAN—ROPEWALK

Scale: 1/8" = 1'-0"



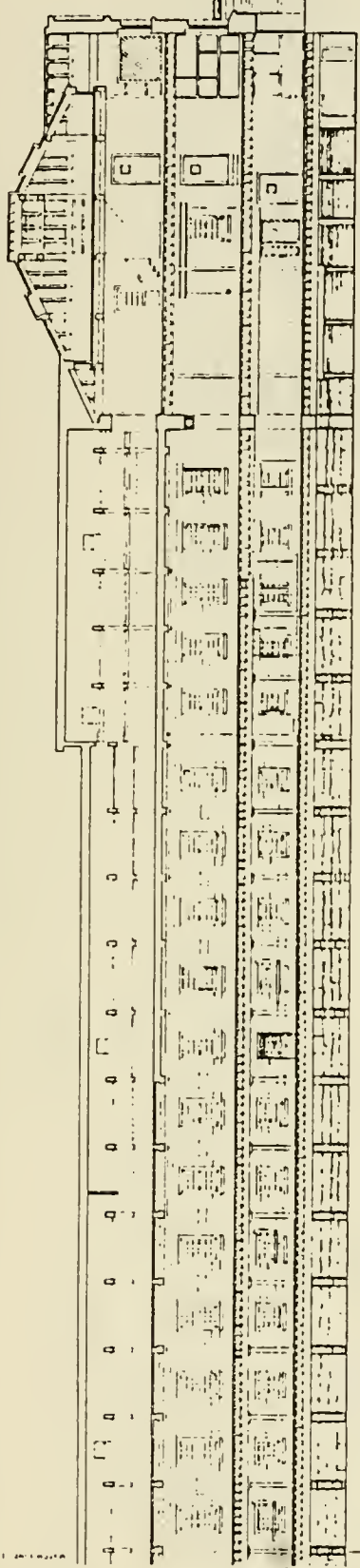
SECTION A-A



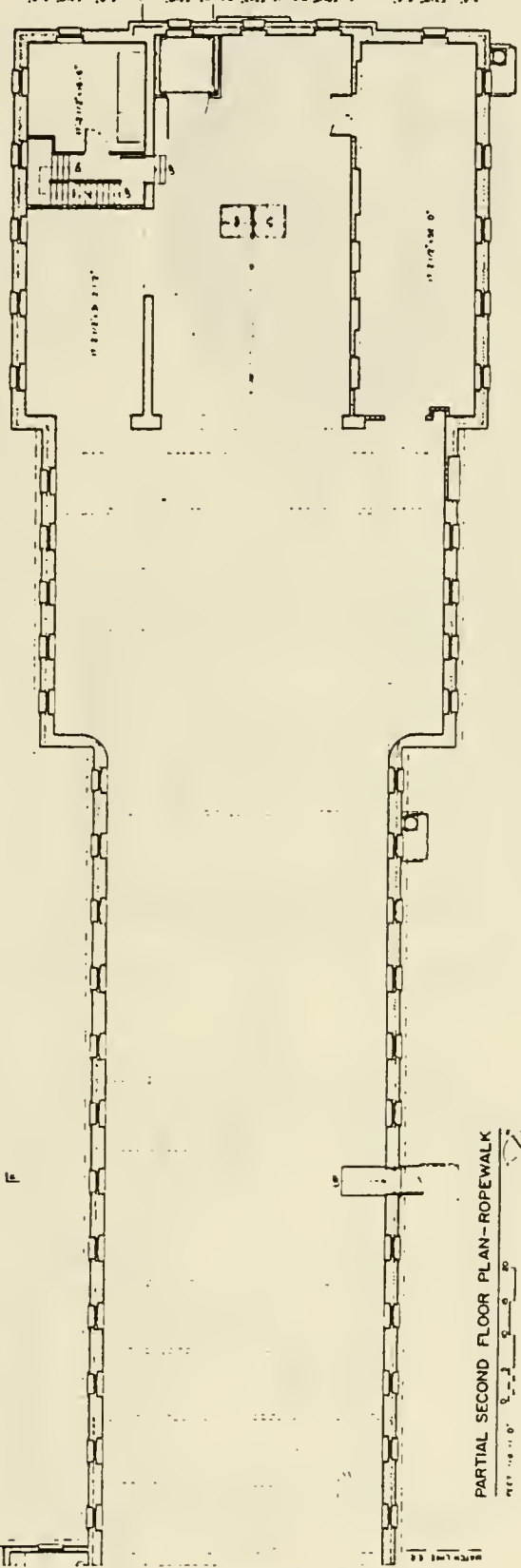
Scale: 1/8" = 1'-0"

ROPEWALK and TAR HOUSE

PARTIAL LONGITUDINAL SECTION - ROPEWALK A-A

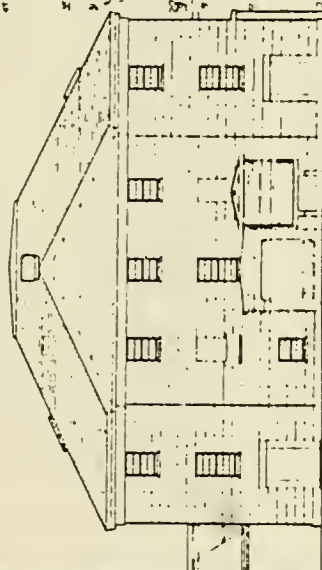


PARTIAL SECOND FLOOR PLAN - ROPEWALK

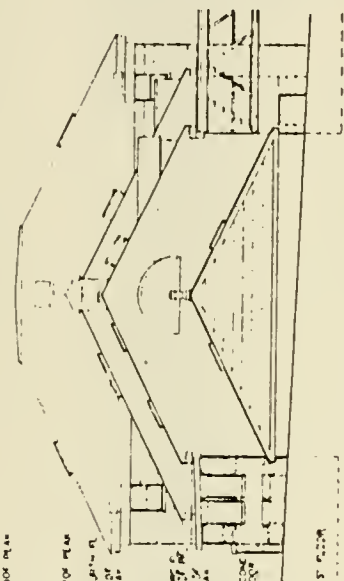


117' 4" TOTAL WIDTH OF ROPEWALK
 117' 4" TOTAL WIDTH OF ROPEWALK
 117' 4" TOTAL WIDTH OF ROPEWALK

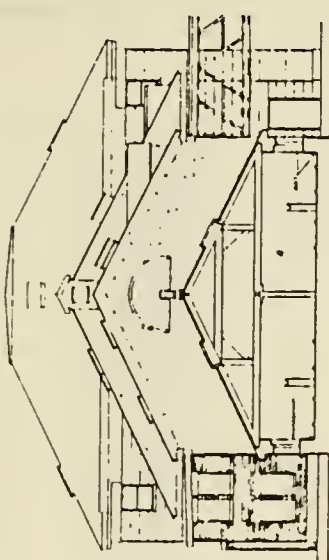
117' 4" TOTAL WIDTH OF ROPEWALK
 117' 4" TOTAL WIDTH OF ROPEWALK
 117' 4" TOTAL WIDTH OF ROPEWALK



NORTHEAST ELEVATION - ROPE WALK

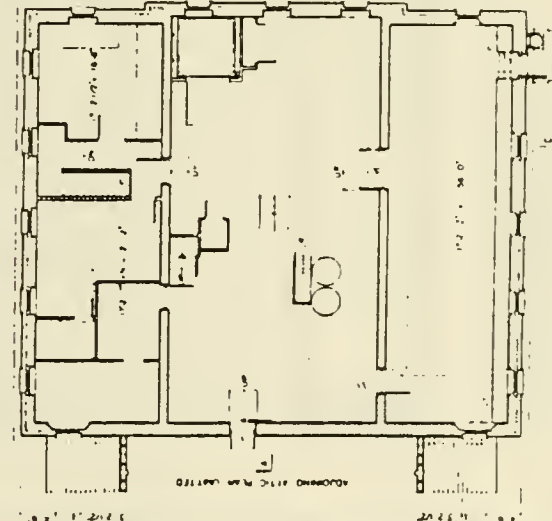


SOUTHWEST ELEVATION - ROPEWALK

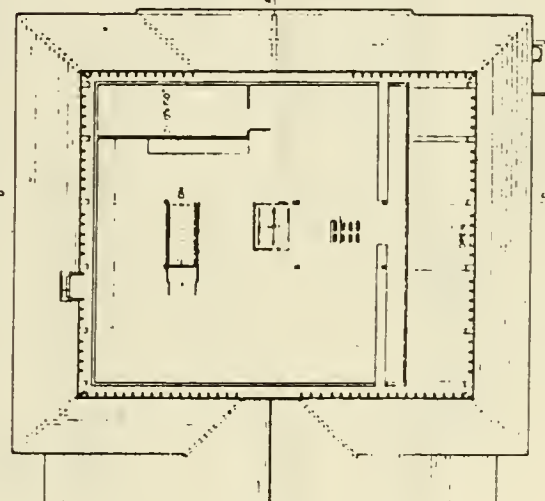


CROSS SECTION - ROPEWALK

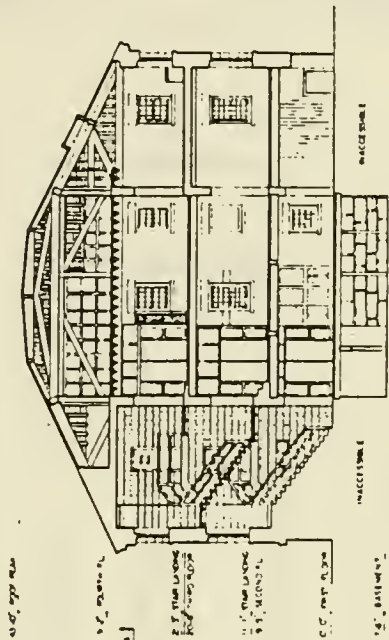
C-C



THIRD FLOOR PLAN - ROPEWALK



FOURTH FLOOR PLAN - ROPEWALK



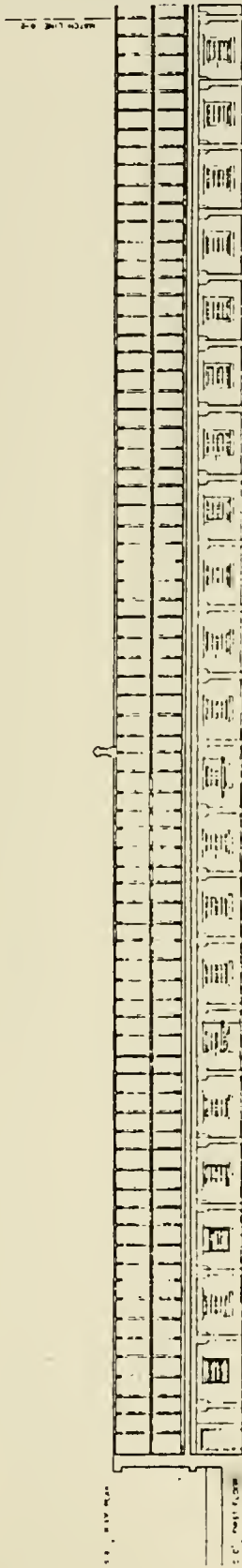
CROSS SECTION - ROPEWALK

D-D

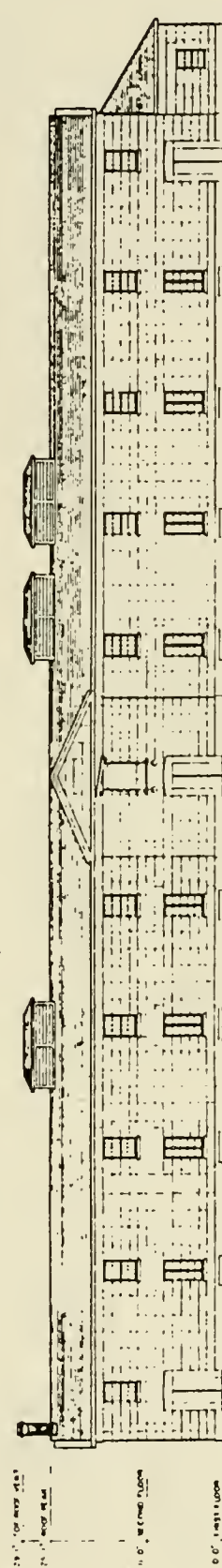
WALLS: 12" EXTERIOR WALLS
 ROOF: ROOFING
 FLOORING: FLOORING
 STRUCTURE: STRUCTURE
 FOUNDATION: FOUNDATION

ROPEWALK and TAR HOUSE

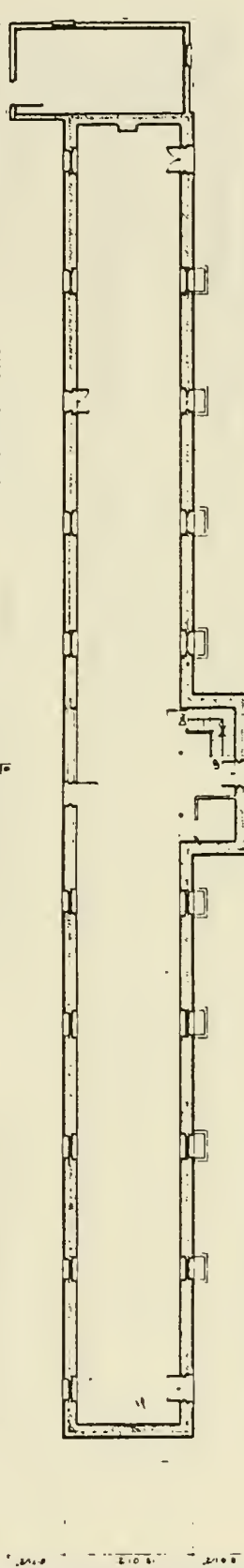
PARTIAL LONGITUDINAL SECTION - ROPEWALK



NORTHWEST ELEVATION - TAR HOUSE



FIRST FLOOR PLAN - TAR HOUSE

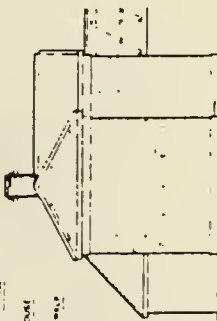
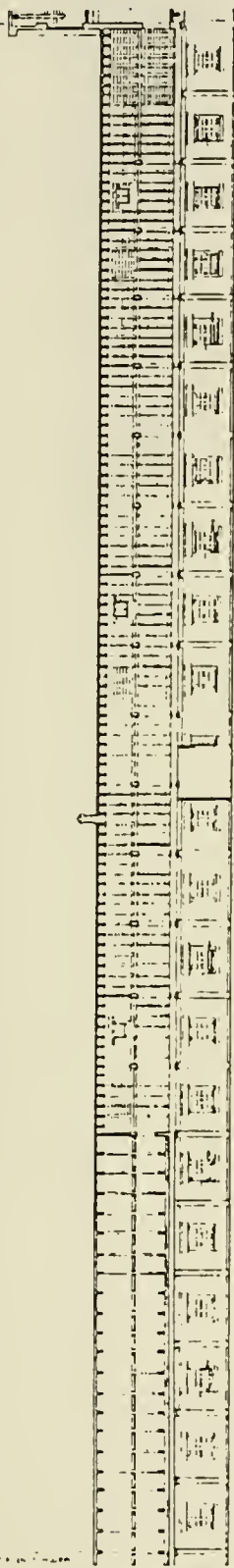


MATERIALS
 EXTERIOR WALLS - WHITE FACED BRICK
 FLOOR - WOOD PLANKING
 ROOF - SLATE TILES

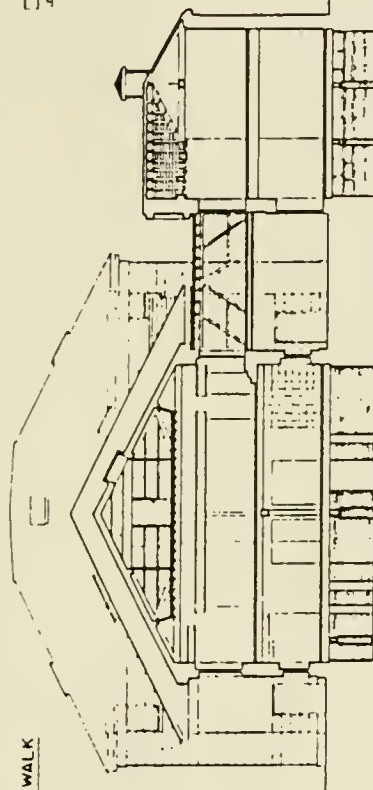
ROPEWALK and TAR HOUSE
 DRAWN BY: J. H. BROWN
 CHECKED BY: J. H. BROWN
 DATE: 1914

ROPEWALK and TAR HOUSE

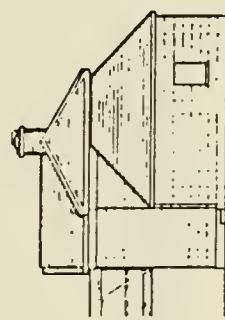
PARTIAL LONGITUDINAL SECTION - ROPEWALK



NORTHEAST ELEVATION-TAR HOUSE

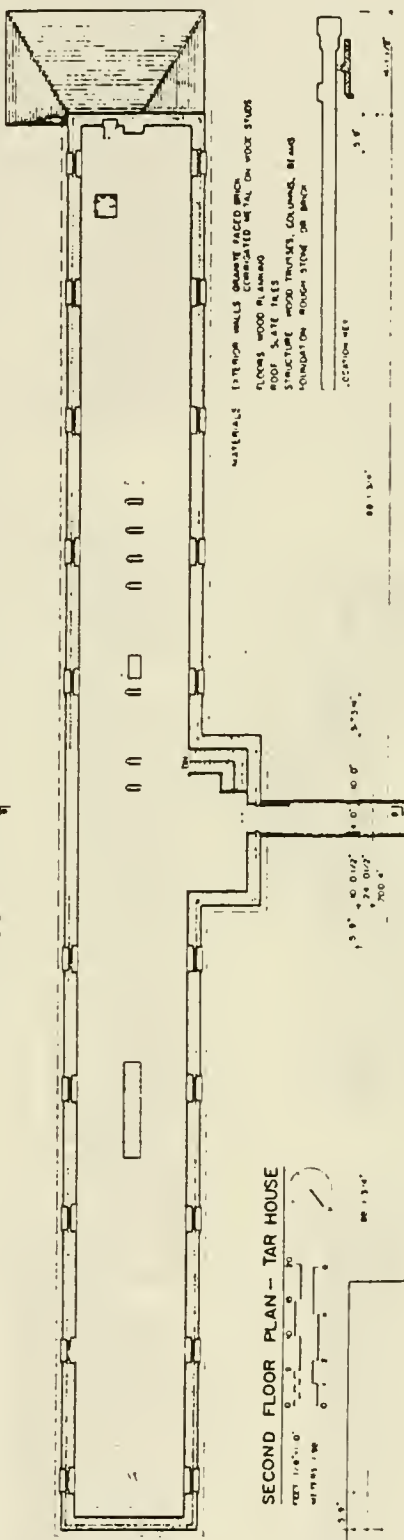


CROSS SECTION - ROPEWALK and TAR HOUSE



SOUTHWEST ELEVATION-TAR HOUSE

SECOND FLOOR PLAN - TAR HOUSE

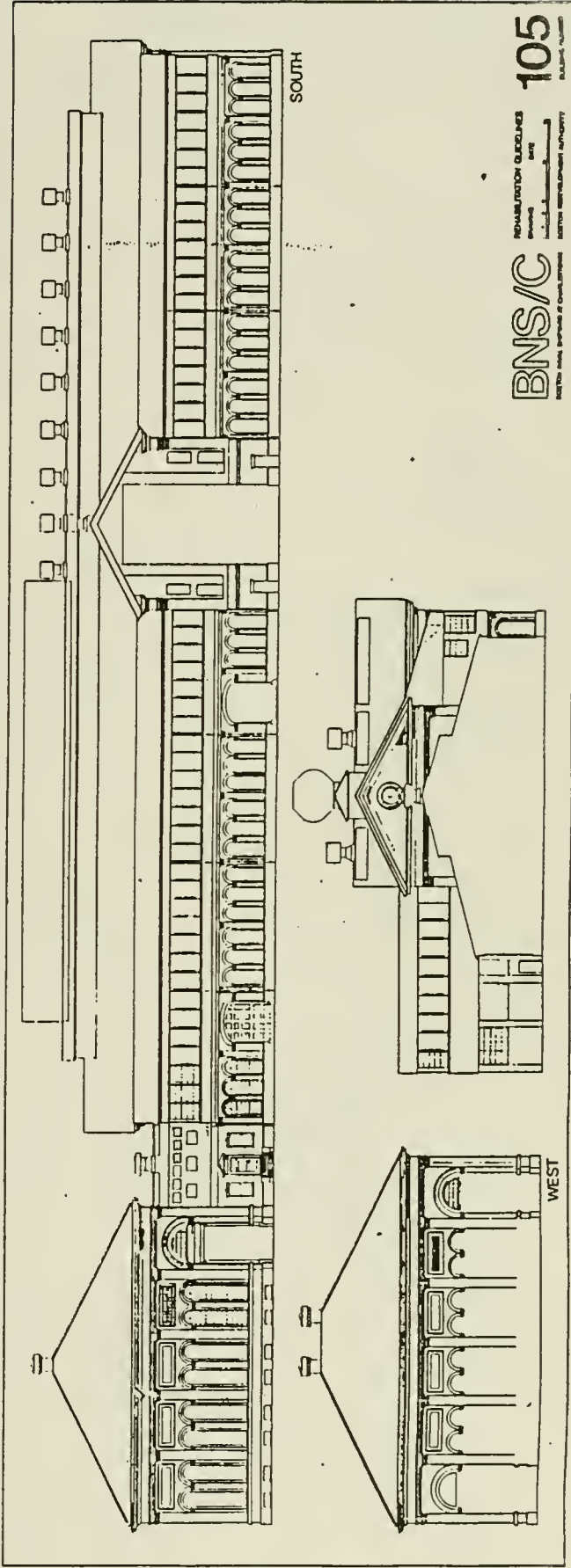
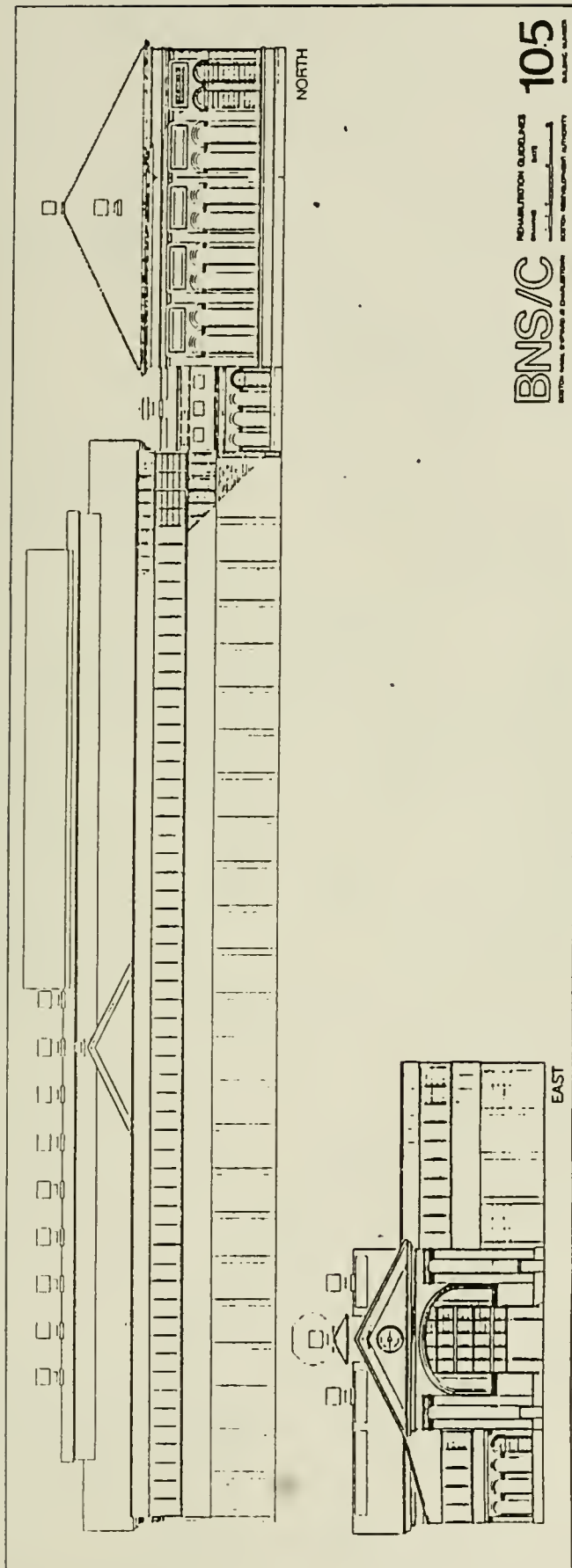


STAIRS
FLOORS WOOD PLANKS
ROOF SLATE TILES
STRUCTURE WOOD TRUSSES, COLUMNS, BEAMS
FOUNDATION WOOD STONE ON GRADE

13'0" x 13'0"

13'0" x 13'0"

13'0" x 13'0"



APPENDIX C
DOUBLE INTERPRETIVE LOOP PLAN

91-2295

**DOUBLE INTERPRETIVE LOOP PLAN
CHARLESTOWN NAVAL SHIPYARD
BOSTON, MASSACHUSETTS**

**CITY OF BOSTON
RAYMOND L. FLYNN, MAYOR**

**BOSTON REDEVELOPMENT AUTHORITY
STEPHEN COYLE, DIRECTOR**

**CLARENCE J. JONES, CHAIRMAN
MICHAEL F. DONLAN, CO - VICE CHAIRMAN
FRANCIS X. O'BRIEN, CO-VICE CHAIRMAN
JAMES K. FLAHERTY, TREASURER
CONSUELO GONZALES - THORNELL, MEMBER
KANE SIMONIAN, SECRETARY**

1991

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1

INTRODUCTION AND OVERVIEW



INTRODUCTION AND OVERVIEW

The proposed Double Interpretive Loop for the Charlestown Navy Yard is a concept which emerged from review of the Charlestown Navy Yard Master Plan with the Massachusetts Historical Commission ("MHC"), the President's Advisory Council on Historic Preservation ("Advisory Council"), the Department of the Interior ("DOI"), the Boston Landmarks Commission ("BLC"), and the National Park Service ("NPS"). Such review was undertaken because the Charlestown Navy Yard Master Plan adopted by the Boston Redevelopment Authority ("BRA") in October, 1990 included elements requiring the amendment of various documents which effectuated the transfer of the Navy Yard, after its decommission in 1974, to the BRA.

The founding of the Charlestown Navy Yard was contemporaneous with the establishment of the U.S. Navy at the turn of the 18th century. In 1799, the U.S. Congress authorized construction of six frigates. Of these, only one -- the U.S.S. Constitution, which is still docked at the Navy Yard -- survives today. It is the oldest commissioned vessel in the U.S. Navy.

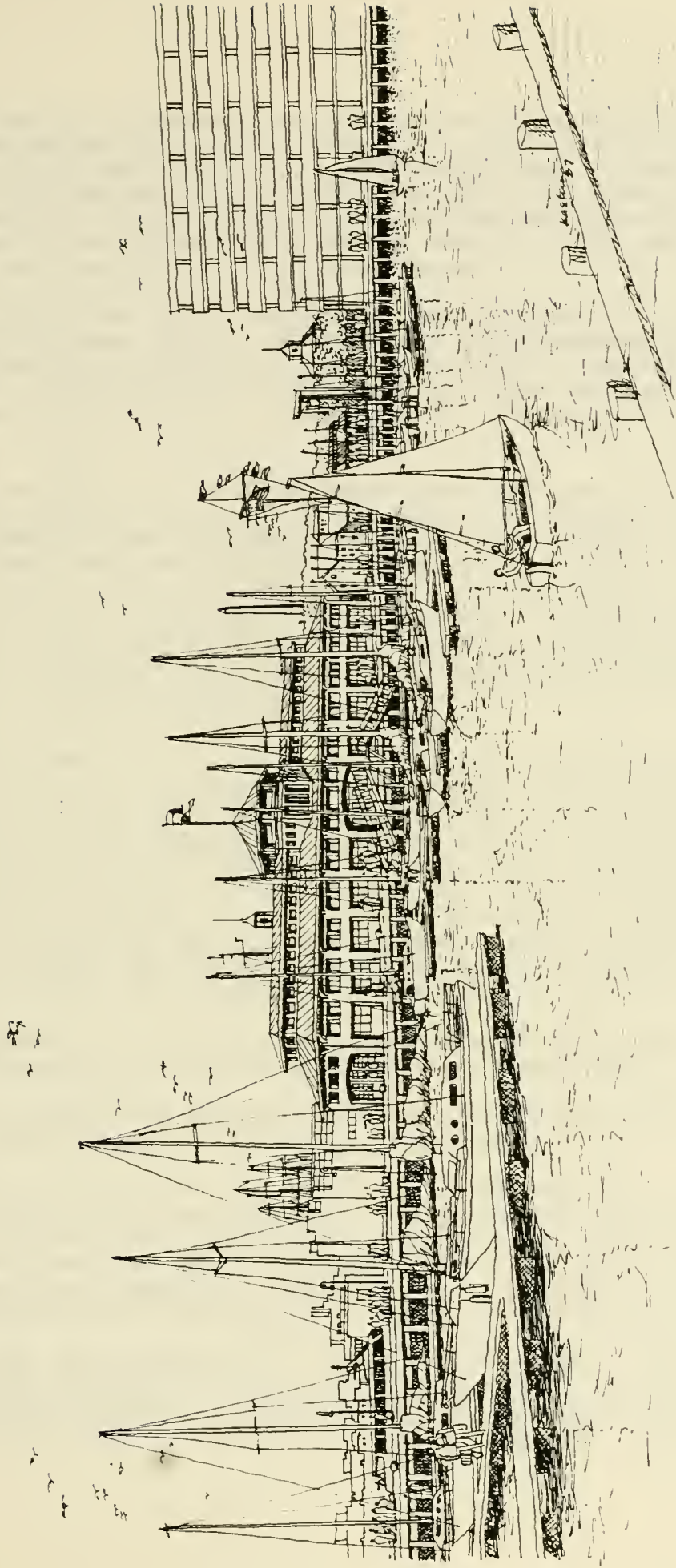
On June 17, 1800, the General Court of the Commonwealth of Massachusetts approved "an Act Authorizing the United States to Purchase a Certain Tract of Land in Charlestown for a Navy Yard." Thus, on the 25th anniversary of the Battle of Bunker Hill was established the young nation's first naval facility.

The first ship to use the Yard was the U.S.S. Constitution, when it was laid up for repairs in March 1801. In 1992, the U.S.S. Constitution will once again undergo repairs in Drydock #1 at the Navy Yard in preparation for the ship's bicentennial.

During the almost 200 intervening years between these occasions, the Charlestown Navy Yard was the site of numerous technological innovations which forged the U.S. Navy into the world's pre-eminent fleet. Early 19th century shiphouses and drydocks revolutionized shipbuilding. Drydock #1, which was completed in 1833, is the second oldest in the country.

The Ropewalk complex, built in 1837, utilized innovative rope making equipment to produce essentially all the rope used by the U.S. Navy for more than a century. The first ironclad vessels, which altered naval warfare after the Civil War, were produced at the Charlestown Navy Yard.

In 1926, two workers invented the "die-lock" manufacture of anchor chain in the Chain Forge Building 105. This manufacturing process resulted in chains of much greater strength, thereby allowing vessels to anchor in deeper and rougher waters than before, thus greatly expanding the fleet's potential for deployment.



During the 20th century, naval sonar and radar were developed at the Charlestown Navy Yard. From 1941 to 1945, 141 ships -- more than at any other facility -- were built here. When the Navy Yard was decommissioned in 1974, its physical appearance represented the cumulative product of one and three-quarter centuries of building construction related to the military and industrial history of the United States.

The BRA acquired approximately one hundred acres of the Charlestown Navy Yard in 1978 and has since managed its revitalization pursuant to plans developed at the time of the transfer. The remaining thirty acres at the western end of the Yard were established as a National Historical Park under the NPS.

The BRA acquisition involved conveyance of three distinct parcels: a Public Park Parcel; the Historic Monument Transfer Area ("HMTA"); and the New Development Area ("NDA"). The Public Park Parcel includes Drydock #2, Pier 4, and the current 8 acre Shipyard Park, which at the time of conveyance was occupied by Building 195 -- a mammoth electrical shed. The HMTA encompasses 31 acres to the north of First Avenue, and includes those existing structures with the greatest historical significance in the Yard. The NDA includes 58 acres between the Historic Monument Transfer Area and Boston Harbor.

The entire Navy Yard is listed in the National Register as a National Historic Landmark. Its transfer out of federal ownership in 1978 involved review pursuant to Section 106 of the National Historic Preservation Act of 1966, which requires that any federal action be reviewed to insure that the adverse effect of such action on properties listed in the National Register be minimized or mitigated. The Section 106 process culminated in various agreements and transfer documents that incorporated measures judged appropriate to mitigate and minimize potential adverse effects of the Navy Yard transfer including:

- o Design Guidelines that established height, use, and other controls for sites in the New Development Area;
- o A Program of Preservation and Utilization that governed redevelopment in the Historic Monument Area.

To date, much has been accomplished to achieve the overall preservation goals articulated for the Charlestown Navy Yard in 1978: Nineteen historic buildings have been rehabilitated and adaptively re-used, and approximately \$470 million of private investment has occurred, making the Navy Yard the largest preservation and re-use project in the United States.

Since 1978, new opportunities to further enhance the Navy Yard's revitalization have also arisen. Accordingly, in 1987 the BRA undertook an extensive community planning process to create a plan that will guide completion of the Navy Yard redevelopment

through the next decade.

The planning principles which evolved over the course of nearly 125 meetings with Charlestown residents, local merchants, harbor advocacy groups, historic preservation officials, organized labor, and other interested groups form the basis of the current Charlestown Navy Yard Master Plan. In addition, numerous meetings held with MHC and other preservation interests have focused on developing specific measures that would minimize and mitigate potential impacts on historic resources.

The 1978 plans envisioned a significant component of light industrial space, in part to ameliorate the elimination of jobs resulting from the Navy Yard's closure. Since that time, regional economic forces have severely effected the viability of these uses in urban core locations such as the Navy Yard. However, biomedical research has emerged as a new growth economy, providing a broad range of employment opportunities that can take up the slack in light industrial jobs.

The Charlestown Navy Yard is well suited to accommodate biomedical research uses. Large, vacant sites available at Yard's End in the New Development Area make it possible to balance the large floor plates required by such uses with the overall building height and mass that is compatible with the existing 20th century warehouse buildings at the Yard, such as Building #149 and #199.

The City's efforts to establish this new economy were successful in 1987 with the conversion of Building #149 into the Massachusetts General Hospital Biomedical Research Center. Other biomedical research uses have since been attracted to the Yard in order to benefit from proximity to this Research Center.

In 1984, the City established the Harborpark planning program for the entire Boston waterfront including the Charlestown Navy Yard. Among its various goals, Harborpark included the provision of continuous public access along the entirety of the water's edge. Prior to this, projects would routinely be designed with private yards, terraces, and balconies along the water. This enhanced private value and marketability at the expense of the public. Harborpark regulations insure that the primacy of access to the water's edge is preserved for the public. Development that welcomes the public rather than privatizing the waterfront has inevitably resulted, and will continue in the future until the entire edge of Boston harbor enjoys continuous, uninterrupted public access.

In 1988, the New England Aquarium unveiled plans to relocate to the Charlestown Navy Yard. The site initially selected was Drydock #2. The Aquarium proposed to build the world's largest, most technologically advanced facility which included a whale tank within the drydock as its centerpiece. Few other uses can be imagined that would better create the type of magnet and

attraction that was envisioned as desirable for the Navy Yard in the 1978 plans. The new Aquarium's proposed location, however, caused considerable concern due to potentially adverse impact on Drydock #2 and the adjacent Shipyard Park.

In response, an alternative location at Drydock #5 in Yard's End was identified, and was subsequently determined to yield even greater benefits than the initial siting. A more efficient aquarium facility could be developed since, in addition to the drydock, adjacent land could be made available at Drydock #5, unlike at Drydock #2 which was hemmed in by the National Historical Park and Shipyard Park. This made possible a circumferential exhibit design which is preferable to a linear one.

Relocation of the New England Aquarium to Drydock #5 also mitigated the adverse impact on Drydock #2 which was built of granite block in 1899. Drydock #5, however, was built of sheet steel and concrete during World War II and is presently in derelict condition. Accordingly, the plans that evolved capitalize on the strengths of the proposed New England Aquarium to become the public attraction envisioned as desirable at the time of initial transfer, without adverse impact on existing historic resources in the remainder of the Navy Yard.

The Aquarium at Drydock #5 will establish a dynamic relationship with the U.S.S. Constitution at the other end of the Navy Yard. People will circulate between these two "magnets," thus making the entire Charlestown Navy Yard more familiar, accessible, and significant as a public resource.

To further build upon this dynamic relationship, the Navy Yard Master Plan proposes the creation of a Double Interpretive Loop that ties the two major attractions into an overall system which enhances people's appreciation of the entire Yard as an historic resource. Through a series of informational and wayside exhibits, the Double Interpretive Loop will inform those visitors whose primary trip purpose is the New England Aquarium, for example, about additional attractions available at the Navy Yard, prominently featuring, and directing them along First Avenue toward, the U.S.S. Constitution. Likewise, visitors whose primary trip purpose is the U.S.S. Constitution will be encouraged to also visit the New England Aquarium.

Midway along First Avenue between the U.S.S. Constitution and the New England Aquarium is the Chain Forge Building 105 -- the site of one of the most important 20th century technological achievements of the Charlestown Navy Yard. An exhibit built around the invention of "die - lock" chain manufacture at this location would not, by itself, be expected to attract broad interest. However, as part of an overall system which draws on the tremendous attraction of the U.S.S. Constitution and the New England Aquarium, an interpretive exhibit at the Chain Forge Building 105 could be more successful.

This is the essence of the Double Interpretive Loop -- a system which ties the Yard's more esoteric historic resources to the two major attractions that generate visitation. Thus, people's exposure to the entire Navy Yard as an important historic resource will be increased.

For their return journey from either the U.S.S. Constitution or the Aquarium, the Double Interpretive Loop will direct people back along either of two paths. One is along Harborwalk at the water's edge. Wayside exhibits about shipways, shiphouses, drydocks, piers, and marine railways would be located along Harborwalk. Moulton's Point, where the British landed in the Revolutionary War action that culminated at the Battle of Bunker Hill, and the U.S.S. Cassin Young, anchored at Pier 2 in the National Historical Park, are also envisioned as significant interpretive elements along the waterside loop.

The second of the two loops will be a landside path, routed through the center of the Historic Monument Area. Interpretive elements are envisioned at the Commandant's House, the unique octagonal Muster House, Flirtation Walk, and Captain's Quarters. The Ropewalk complex is proposed to house an interpretive exhibit that features one of the most significant 19th century technological achievements of the Charlestown Navy Yard.

The Double Interpretive Loop has tremendous potential to realize the goal implicit in the designation of the entire Charlestown Navy Yard as a National Historical Landmark. The Loop will increase the exposure and potential for viable re-use of historic resources which presently lie underutilized. It creates a framework for interpreting the Navy Yard as a whole to millions of future visitors who will come away with both a broader and deeper understanding of the historic significance of the Charlestown Navy Yard than is possible today.

A number of opportunities to enhance the Navy Yard have arisen in the decade since its transfer to the BRA. The Charlestown Navy Yard Master Plan capitalizes on these opportunities by providing for relocation of the New England Aquarium to Drydock #5, establishing a Double Interpretive Loop to tie the entire National Historic Landmark into a coherent interpretive experience, creating a significant center for biomedical research at Yard's End, and infusing Harborpark's public access goals throughout the Navy Yard.

Because these opportunities were not foreseeable in 1978, the various agreements and documents which effectuated the Navy Yard transfer must be amended to fully secure the benefits of the Master Plan. Accordingly, the BRA has met on numerous occasions from the spring of 1990 with MHC, the Advisory Council, BLC, DOI, and NPS to review the proposals contained in the Master Plan and to develop measures to minimize and mitigate any adverse impacts on historic resources. During the course of these discussions, the Double Interpretive Loop has been identified as a significant

element of mitigation.

Turning the Double Interpretive Loop concept into reality will involve concerted effort among all parties who have participated in its evolution to date. In this regard, the BRA will continue to staff and help coordinate further input from local, state, and federal preservation interests. Detailed studies of signage, barrier-free access, programming, and funding will be undertaken toward implementation of the Double Interpretive Loop on a contemporaneous schedule with the Charlestown Navy Yard Master Plan buildout.

This Double Interpretive Loop Plan for the Charlestown Navy Yard lays out general goals and objectives. Identification of possible exhibit sites is included for discussion. The scope and schedule for completing the plan is proposed, and an annotated bibliography to serve as a reference framework during detailed plan development and refinement is provided.

2

HISTORY OF THE CHARLESTOWN NAVY YARD



CHARLESTOWN NAVY YARD HISTORICAL TIMELINE



A SHIPYARD FOR THE YOUNG NAVY

1799 Congressional appropriation for new naval facilities

1800 On June 17 (Bunker Hill Day), Massachusetts Legislature approves Act authorizing U.S. to purchase a tract of land in Charlestown for use as a navy yard

1801 Captain Samuel Nicholson - first Commander of the U.S.S. CONSTITUTION - appointed Superintendent of the new Navy Yard by President Thomas Jefferson

1805 Commandant's House one of the first new buildings

EARLY MILESTONES

1812 War of 1812 spurs shipbuilding program

U.S.S. CONSTITUTION continues to distinguish herself in naval battles, earning the nickname, "Old Ironsides"

1813 Commodore William Bainbridge (1774-1833) develops revolutionary concept of complete cover for shipbuilding: first shiphouse prototype

First ship launched at Charlestown Navy Yard: U.S.S. FROLIC

1815 Bainbridge establishes School for Naval Officers; precursor to Naval Academy

1823 Bainbridge prepares report on condition of Yard; plants hundreds of elm trees

1827 Congress enacts legislation directing President John Quincy Adams to upgrade all of the Navy Yards

Loammi Baldwin Jr. (1780-1838), "Father of American civil engineering," designs and superintends construction of the Navy's first drydocks at Norfolk and Charlestown

1828 Master Plan for the Navy Yard prepared by Baldwin and assistant Alexander Parris (1780-1852)

1832 First granite building (Bldg. #22 Engine House) at Navy Yard completed by architect Parris, utilizing his prior experience designing forts and lighthouses along the coast of Maine; later designs Building #34 and Timber Sheds

1833 Drydock #1 completed; U.S.S. CONSTITUTION admitted June 24 for repairs

1838 Alexander Parris' Ropewalk complex is completed, using state-of-the-art machinery designed by inventor Daniel Treadwell (1791-1872); commences operation and is designated to supply all of the rope for the entire United States Navy

1852 Joseph E. Billings succeeds Parris as Chief Civil Engineer; later transforms the appearance of the Yard with several new facilities (Buildings #31, #33, #36, #38, #39, #40, #42 and #79)

1855 Screw frigate MERRIMAC launched

1858 Building #42 (Steam Engineering Building) represents culmination of Billings' career; ushers in age of steam in Navy shipbuilding and dramatically transforms the scale of the Navy Yard

1863 First iron plate for armoring wooden ships is fabricated in Building #40 (Heavy Hammer Shop)

NEXT MAJOR PERIODS OF GROWTH

1883 U.S. Government begins to mobilize the "New Navy," after years of neglect; iron and steel ships belatedly introduced

1903-05 Large-scale Renaissance Revival brick structures designed to accommodate cranes and rail cars are constructed: Buildings #103, #104, #105, #106, #107, #108, #114, #120 and #123

1905 Drydock #2 completed; U.S.S. MARYLAND launched at opening celebration

1908 Slate color adopted as Navy ship color; more economical and less conspicuous at sea than white

1914 World War I begins: Shipyard is used mostly for outfitting and repair

1918 Large marine railway constructed

1920 Shipway #1 built on site of third Shiphouse (erected 1824), from which MERRIMAC had been launched; four large hammerhead cranes (now demolished) ushered in a new scale of steel ship construction

1926 Shipyard workers A.M. Leahy and Dr. Charles G. Lutts invent "die-lock" chain in Chain Forge Building #105, which propels the Boston facility back into the forefront of naval research activities and later helps the allies win World War II by enabling aircraft carriers and other large vessels to anchor in deep seas

1941-45 World War II: the Yard springs into action with a flurry of shipbuilding; a total of 159 ships constructed, including 36 Destroyers, 59 Destroyer Escorts and 44 Landing Ship Tanks

1942 Drydock #5 completed

1943 Boston Yard builds more Destroyer Escorts (46) in shorter time than any other public or private yard

19 WWI "four-stackers" reoutfitted and sent to Britain under the Lend Lease program

1944 Women constitute 40% of the work force, having filled the gap left by thousands of shipyard workers who entered military service

1956 Last ship launched at the Yard (from Shipway #1) is U.S.S. SUFFOLK COUNTY

1961 U.S.S. GYATT becomes first guided-missile destroyer; Yard begins to fit ships with bow-mounted sonar rooms

1971 Rope ceases to be made at the Ropewalk: the end of an era

Navy's first high-power Control-lable Pitch Propeller designed at the Yard

THE NAVY YARD CLOSES

1973 173 Years of partnership between the City of Boston and the Navy ends with the closing of the Yard

1974 Boston National Historical Park, a unit of the National Park Service, is created

1978 Portions of the Navy Yard are transferred to the Boston Redevelopment Authority for preservation, rehabilitation and redevelopment

HISTORY OF THE CHARLESTOWN NAVY YARD

Following the Revolutionary War, the new nation, tired of conflict and eager to get on with building a free society, sold its fighting ships and sent its sailors home. On March 22, 1794, Congress authorized the building of six 44-gun frigates as the first stage in the establishment of a new navy, with one to be built at Hartt's Yard (Constitution Wharf today) in the North End of Boston. The Constitution was launched in October of 1797, seven months after the inauguration of President John Adams, an advocate of a first class Navy.

In response to legislation passed in 1799 designed to strengthen the Navy, Benjamin Stoddert, the first Secretary of the Navy, dispatched naval constructor Joshua Humphreys to New England in search of sites for "building yards". As a possibility, Humphreys identified a point of land overlooked by Dr. Aaron Putnam's mansion house in Charlestown. Called Moulton's Point, the site was located at the confluence of the Charles and Mystic Rivers. It was also the place where British General William Howe led his troops ashore on June 17, 1775 en route to Breed's (Bunker) Hill. At the time of Humphreys' visit, Ebenezer Breed, a tinman, owned a substantial pasture on the point.

The Charlestown selectmen and others, desirous of luring the Navy to their shores, sent Aaron Putnam to Philadelphia to lobby President Adams, who eventually concurred and appointed Putnam U.S. agent in charge with acquiring twenty-four and one half acres of land.

In honor of the 25th Anniversary of the Battle of Bunker Hill, on June 17, 1800, the General Court of the Commonwealth approved "An Act Authorizing the United States to Purchase a Certain Tract of Land in Charlestown for a Navy Yard," not to exceed 65 acres, exclusive of flats.

By April 3, 1801, the transfer of ten lots was completed. Additional purchases were made in 1817, 1863, and 1920; and considerable land was added over the years by filling in the marshes and mud flats and reordering the shoreline to arrive at the 84 acres of land and 46 acres of water constituting the present Yard.

Planning for the Navy Yard began even before completion of land acquisition. In November of 1800, Secretary Stoddert wrote to Putnam and to Higginson and Company, Navy Agent in Boston, regarding estimates for "building a proper wharf" for construction of a 74-gun ship, as well as for a 75-by-150 foot brick and stone storehouse.

On June 12, 1801, President Jefferson appointed Samuel Brown as Navy Agent on April 1, 1801. On June 12th he appointed Captain Samuel Nicholson - who had supervised construction of the Constitution and was its first commander - as first Superintendent of the Navy yard. Nicholson was the first of three naval heroes who commanded the Constitution and were similarly rewarded. His successor in 1812 was Captain William Bainbridge, victor over H.M.S. Java on December 29, 1812. During Bainbridge's intermittent tour at the Yard, Captain Isaac Hull, conqueror of the Guerrierre on August 19, 1812, served as Commandant from 1812 to 1813 and 1815 to 1823.

Osgood Carleton was commissioned to prepare a map of the yard in 1802. Included was a plate of the grounds in three divisions showing both in-place buildings and proposed improvements. Existing buildings, scattered in the western quadrant, included a storehouse for live oak, a covered saw pit, a barracks, and a carpenters shop, plus a blacksmith shop and laborers quarters, both pre-existing and purchased by the U.S. Most of the land was described as pasture for public oxen. Also in 1802, five acres were appropriated for a Marine Hospital, completed by 1805.

In 1805, the brick Superintendent's Residence was completed near the northwest boundary, and by late 1809, a two-story brick magazine and a two-story brick Gun House were in place. A barracks, also of brick, was built in early 1811 at which time the Parade Ground was ordered laid out.

Superintendent Bainbridge's inventory of the yard in 1812 included the following: (a) Commandant's House, (b) Marine Barracks, (c) frame three-story storehouse 60' X 40', (d) Magazine (e) old one-story wood building, (f) very old small structure in ruins, (g) two one-story frame sheds for timber, (h) Blacksmith Shop, (i) stone lip or landing place, (j) dam or cobb wharf, (k) temporary fences. Condition was described as rundown.

By autumn, 1813, a new wharf and large three-story brick Navy Store with a slate hipped roof, plus a Blacksmith Shop, were built. The store survives as Building 5. The year 1813 was a notable year for the Yard, nautically and architecturally, with construction of its first ship begun and its first Shiphouse completed. The Shiphouse was a remarkable structure. The huge, gambrel-roofed, timber-framed, many-windowed building, 210' X 70' X 50' high, enabled a ship to be constructed indoors. It was the second of its species to be built, one in Portsmouth having preceded it by a few months. The Shiphouse survived long enough to see the 74-gun Independence launched on June 22, 1814, but succumbed to a wind storm two months later. It was rebuilt, somewhat larger, in 1819.

Additions to the Yard during the next decade included a Spar and Boat Shed plus a two-story brick Porter's Quarters in 1817, three Timber Sheds in 1818, 1821, and Shiphouse No. 2, 260' X 162' X

80' in 1822. (In later years two more Shiphouses were located on either side of No. 2: Shiphouse No. 3, in 1826 and Shiphouse No. 39 in 1841.) Subtractions included two frame buildings and a major part of the Marine Hospital which burned in 1818. The hospital was relocated to Chelsea in 1825, and what remained of the building was taken down and the bricks reused to build a row of four new quarters. A new hospital and magazine in Chelsea were designed by Alexander Parris in 1831 and completed in 1836. Peter Tufts' "Plan of the Charlestown Peninsula" of 1818 shows the Navy Yard as a vast open space with groups of five buildings plus "Navy Yard Wharf" at the southwestern end, and seven buildings (including the hospital) at the northeast. An 1823 plan of the "Navy Yard, Charlestown, Mass." locates 20 buildings, including those labeled as Commandant's House, Barracks, Powderhouse, Shiphouse No. 1, Shiphouse No. 2, Saw Shed, Hospital, Pier (with Columbus, Independence, and Java at anchor), four docks including a "Dock for Timber", Old Road, New Road, and Road No. 2.

Prior to the engineering and architectural influence of Colonel Loammi Baldwin and Alexander Parris, beginning in the late 1820's, the Yard exhibited a decidedly rural aspect. One of the chief concerns during the early decades was the proper storage of timber, particularly live oak and yellow pine, the essential ingredients in ship construction. Storage was in sheds or storehouses or under water in a dock specially designed to age the wood slowly, as shown in the 1823 plan.

Commandant Hull had proposed a brick wall enclosing the Yard in 1816, but it was not until 1824 that the first 600-foot portion, by then stone, from Water Street to the Salem Turnpike (now Chelsea Street) was completed. That same year Alexander Parris was retained to prepare a plan for the extended segment along the Salem Turnpike, probably because of his recent experience in building walls for the Charlestown Prison. The 2,400' X 9' X 20" granite wall was completed on October 12, 1826, within months of the opening of his Faneuil Hall Market buildings in Boston. The wall and its granite announced a new and glorious era in Navy Yard construction.

On March 3, 1827, Congress enacted legislation directing President John Quincy Adams "to cause the Navy Yards of the United States to be thoroughly examined and plans to be prepared and sanctioned by the President for the improvement of the same...". That same spring President Adams appointed Commodores Bainbridge, Chauncey, and Morris to carry out the law. Colonel Loammi Baldwin Jr. (1780-1838) was named engineer charged with assisting the board in surveys and preparation of plans.

Baldwin, considered the father of civil engineering in America, had a profound effect on the Navy Yard as well as on the entire Boston area. His father, Loammi Baldwin Sr., planned the Middlesex Canal, completed in 1804, and is said to have developed the vulcanizing process. The younger Baldwin took over and

completed the Mill Dam project in the Back Bay, following Uriah Cotting's death in 1819. He was the first of a quartet of major Boston architect/engineers to work at the Navy Yard, the others being Alexander Parris, Gridley J.F. Bryant, and Joseph E. Billings.

On August 11, 1828, a "Plan of the Navy Yard at Charlestown, Mass., showing the positions and dimensions of the Ground Plans of the different Buildings, Docks, and other Improvements as recommended by the Board of Commissioners" was issued. The plan completely transformed an agrarian peninsula with a few scattered buildings, docks, and wandering roads into an urban industrial complex laid out as a classical grid dominated by five broad avenues running southwest to northeast intersected by seven cross streets. Proposed buildings, rectangular in shape, were regimented to conform to the street pattern, the exception being the Ropewalk shown at a diagonal parallel to the Salem Turnpike. The existing Shiphouses seemed a bit tipsy in their non-axial positioning. While the plan was not followed in every detail, the spirit of the grid dominated all future development. Although Alexander Parris has been credited with this plan, Loammi Baldwin was clearly in charge of the preparation and it is unlikely that the design does not bear the imprint of his experience.

Preliminary construction for the Drydock began on August 24, 1827, with the first stone being laid for the Cofferdam. The project was completed in mid-1833, and the Constitution, which had been waiting three years for repairs, was admitted on June 24th. The Drydock was extended 65 feet seaward in 1856-57 and again reconstructed in 1948.

Alexander Parris (1780-1852) came to the Navy Yard in 1827, after a distinguished architectural career, primarily in Maine and in the Boston area. He had experience in military architecture, having designed about a dozen buildings between 1816 and 1820 for the newly established Arsenal in Watertown, relocated from the Charlestown Navy Yard.

Although these structures were in brick, they exhibited the type of strength and restrained elegance which would be translated into granite in Charlestown. Other major buildings designed by Parris between Watertown and Charlestown included Parker-Appleton Houses (1817-19), St. Paul's Cathedral (1819-20), David Sears Mansion (1819-21), Suffolk County Jail and Courthouse (1820-22), Faneuil Hall Market (1824-26), all in Boston, and the Stone Temple (1827-28) in Quincy. Parris, perhaps more than any other Boston architect, established the Greek Revival as the prevailing style from the 1820s to the 1840s and granite as the preferred material to the 1860s.

In addition to his work on the Drydock, Parris designed an Engine House (Bldg. 22) built in 1830-31, a Storehouse (Bldg. 34) of 1835-37, and several slips and quay walls. His most significant

project was the Ropewalk, designed in 1834 and built from 1835 to 1837 at a cost of more than \$340,000. Constructed of Quincy granite backed with brick, with a slate roof, the Ropewalk measured 1,360 by 45 feet. Originally one-story for most of its length, with a three-story Head House, it acquired matching granite additions in 1856 and 1908, extending the second floor by 848 feet. Its unique spinning and twisting machinery, as well as its steam boilers and engines, were designed by Daniel Treadwell of Boston between 1828 and 1834. From its completion until 1955, the Ropewalk supplied all the rope used by the U.S. Navy. Included in the complex were two subsidiary buildings, the two-story, 200' X 19' granite Tarring House and the two-story, 140' X 160' granite Hemp House.

Parris may have had a hand in, and certainly influenced, the designs of other buildings as well. His last project was to execute record drawings of recent improvements in the Yard, which he completed in 1840.

Gridley J.F. Bryant (1816-1899) had become Parris' assistant in 1832, but no Navy Yard buildings have been attributed to him. By mid-century Bryant had become Boston's leading architect and a master manipulator of granite. Among his major works in Boston are the Charles Street Jail (1848-51) and, with Arthur Gilman, the Old City Hall (1862-65), both executed in granite.

The career of Joseph E. Billings (1821-1880) as an architect began with the Boston Museum project (1845-1846) designed in collaboration with his brother Hammatt (1818-1874). The Museum, an elegantly detailed, Italian Renaissance Revival Structure of Quincy granite, located on Tremont Street, was one of Boston's finest buildings at the time of its construction. Among Billings' other notable buildings were the National Theater, Odd Fellows Hall and the Second Cathedral Building. Unfortunately, none of them has survived.

Several Navy Yard buildings dating from the 1840s and early 1850s have been attributed to Billings. Included are the two-story granite Carpenters and Joiners Shop (Building 24) of 1847, the two-story brick Tinnerns and Plumbers Shop (Bldg. 28) of 1849-50, the unique octagonal brick Muster House (Bldg. 31) of 1852-54, and a three-story granite Storehouse (Bldg. 33) of 1850-52. A problem arises, unless dates are incorrect, since Billings was not appointed Chief Civil Engineer at the yard until July of 1853, a post he held until 1866.

Those buildings designed by Billings within his 13-year tenure include the three-story granite-faced Cooperage and Packing House (Bldg. 38) of 1854, which burned in 1978; the one and two-story brick Steam Engineering Building (later the Machine Shop and Foundry, Bldg. 42) of 1856-58, heavily altered in 1901-1910 and during World War II; the two-story brick Boiler House (Bldg. 79) of 1857; the two-story brick Heavy Hammer Shop (Bldg. 40) of 1863 (west elevation demolished in 1939-41 for Bldg. 42A); the

three-story, slate-roofed Sail Loft and Joiners Shop (Bldg. 36) of 1866; and the three-story brick Ordnance Storehouse (Bldg. 39) also of 1866.

A beautifully detailed, 239 1/2' brick chimney attached to the Steam Engineering Building was Billings' most spectacular contribution to the Yard. It survived only until 1903. His earliest work continued the robust Parris use of rugged, quarry-faced granite but with subtle additions of Renaissance-inspired detail. Later he shifted to brick as the principal material with more pronounced Renaissance trim executed in granite, thus gradually ending the Navy Yard's granite era.

In 1851 the following somewhat romanticized description of the Charlestown Navy Yard was printed in the popular magazine, Gleason's Pictorial Drawing Room Companion: "The Yard within the walls covers an area of about seventy acres... There are three ship-houses and slips for building vessels under cove. Two large store-houses 200 feet by 66, built of Quincy granite, and other buildings exclusively for stores and munitions of war. There are four timber sheds of 450 feet in length, in which there are stowed, at this time, frames of live oak for sixteen ships of the various rates in our navy, ships of the line, steamers and frigates.

"The most remarkable building...is the Ropewalk, 1350 feet in length, and having double laying grounds. The spinning is done by machinery in a room containing eighty machines, and with the laying grounds and tarring machinery, is capable of turning out rigging of all sizes, from the largest cable to the smallest lines used in the navy, to the amount of five tons daily."

"The blockmakers' shop with its improved and beautiful machinery, is pronounced. To be the most complete establishment of its kind found anywhere. The gun-carriage shop, saw-mill, and planing-machines; the smithy, foundry, etc., are also well adapted to this great naval depot and workshop. The whole Yard is laid out into streets and avenues, which are either paved or gravelled, and bordered with elms, maples or other ornamental trees, affording one of the most beautiful promenades in this part of the country. There is a magnificent park for heavy cannon... There is also a shot park, with many thousand balls piled in the neatest manner, and an anchor park, in which are the largest anchors for men-of-war."

Construction came to a standstill at the end of the Civil War and did not revive until the turn of the century.

Rear Admiral George Henry Preble's description of the Yard in 1881 reads in part: "There are now... twenty brick, eleven stone, thirty-six wooden, and two iron buildings, besides numerous temporary sheds and buildings. Only eight buildings are standing which are on the yard plan of 1823... There are two avenues running lengthwise of the yard, ornamented with shade trees; and "Flirtation Alley", along the inner side of the

Ropewalk, with its shady trees and plank-walk, is a well-known resort of lovers on moonlight nights..."

Although it would be 20 years before the effect reached Charlestown, the beginnings of the "New Navy" can be traced to 1883, when the Congress embarked on a program of building modern, steel-hulled warships. In 1886, the yard was all but shut down except for equipment production. Deterioration was rampant.

By 1903, an extensive building program was under way, yielding ten new structures over the next two years (Bldgs. 103, 104, 105, 106, 107, 108, 114, 120, 123, 125). All were brick with steel or concrete frames, a pattern which continued through World War I. The Colonial and Renaissance revival details of the first 20th century buildings soon gave way to a stripped-down factory style. As a prelude to the early 1900s "improvement" program, the first of the cluster of three great timber Shiphouses had been taken down in 1901, and by 1903 the remaining two had suffered a similar fate.

To supplement the drydocks, a Marine Railway was installed in 1918, lacing through the yard's avenues and streets.

The period between the two world wars represented another lull, enlivened only by the development of the "Die-Lock Chain." Invented by A. M. Leahy and Dr. Charles G. Lutts, it revitalized the research aspect of the yard.

In 1938, Congress approved President Roosevelt's request for \$1 billion for naval defense. That same year the Navy Yard launched two 1500-ton destroyers, the USS Mayrant and the USS Trippe, and also began a construction program of large, and largely undistinguished, buildings.

Originally known as the United States Navy Yard at Charlestown, or, simply, the Charlestown Navy Yard, the name was changed to the Boston Naval Shipyard in 1945. Ship launchings and repairs reached an all-time high during World War II, with a labor force of 47,000, up from 2,860 in 1938. Between 1941 and 1945, 141 new ships were built, many of which were destroyers, destroyer escorts, and LST's.

Also, 3,260 ships were overhauled and 1,820 were docked. The Yard's last great contribution was the development of bow-mounted sonar rooms for guided missile destroyers in 1966. The last ship to be commissioned was the Kalamazoo, a replenishment oiler, in 1973.

Building construction ceased after World War II. Production ended at the Ropewalk in 1971 and the Department of Defense announced the closing of the Navy Yard in April of 1973, ending employment for 5,200 workers. Ceremonies for decommissioning the Yard were held on July 1, 1974.

From the Independence, a ship of the line launched in 1814, to the Kalamazoo, the Charlestown Navy Yard commissioned about 500 ships. Notable among these, in addition to the first, were the schooner Alligator (1820); the Merrimac (1855), a screw frigate later converted by the Confederacy to an iron clad and defeated by the Monitor in 1862; the screw sloop Hartford (1858), Admiral Farragut's flagship; the Monadnock (1866), a double-turreted iron clad, the first monitor iron clad to sail from the Atlantic to the Pacific; and the iron clad Intrepid (1874), the first torpedo boat. The Constitution was the first and last ship to be repaired in the Yard.

3

DOUBLE INTERPRETIVE LOOP GOALS AND OBJECTIVES

DOUBLE INTERPRETIVE LOOP -- GOALS AND OBJECTIVES

The underlying goal of the Double Interpretive Loop is an enhanced interpretation of historic resources throughout the entire Charlestown Navy Yard. It is intended that this trail foster improved visitor experience, orientation, and more profound understanding of the Yard's role in the military and industrial history of the country.

The Double Interpretive Loop builds on themes established at the time of the Navy Yard's transfer to the BRA. Historic preservation principles contained in the documents which effectuated such transfer have and will continue to guide realization of the Double Interpretive Loop. In this regard, Guidelines for the Treatment of the Groundplane (from the "Program of Preservation and Utilization" for the Historic Monument Transfer Area) and the General Guidelines (from the "Design Guidelines" for the New Development Area) provide key elements of an overall framework.

Plans for the National Historical Park will also be integrated with the Double Interpretive Loop. Accordingly, the goals and objectives established in the Revised General Management Plan/Volume II and the Interpretive Prospectus/Volume II for the National Historical Park are complemented by the proposed Loop. From this perspective, a key aspect involves final resolution of NPS plans for a new Visitor Center. Programming the Yard's End visitor center to insure primacy of the NPS facility and avoid duplication of visitor services is intended.

Another important component of the Double Interpretive Loop concept involves marketing the multitude of historical/cultural resources envisioned for the Navy Yard in a coherent fashion. The goal is to enhance the destination value of the Yard as a whole through tourist oriented guides and promotion. In this way, people would be encouraged at the start of their visit to include more than one Navy Yard attraction.

Transportation access is another critical aspect of enhanced visitor experience and orientation. The Charlestown Navy Yard Master Plan provides overall strategies to insure that visitors to all Navy Yard attractions have convenient access to parking facilities. In addition, specific provisions are aimed at enhancing other modes of arrival such as by water shuttle, bus, or on foot.

An intra-Yard bus or tram shuttle service is suggested to complement walking the Double Interpretive Loop. Scheduling will be developed to accommodate variation in visitor volume and profile during the course of the year. Specific route layout will be developed within the framework of previously established historic preservation principles.

The creation of an interpretive program for the pedestrian system of the Charlestown Navy Yard is an exciting opportunity to reveal the many layers of history which the Yard contains. There are currently two other pedestrian systems, the Freedom Trail and the Harborwalk, which will intersect with the Double Interpretive Loop. Combined, these three systems and the programs which are being designed around them will provide the pedestrian with a richness and diversity of experience which will add to their understanding of the city as a unique and special environment.

Intersecting with the Double Interpretive Loop in the Navy Yard will be:

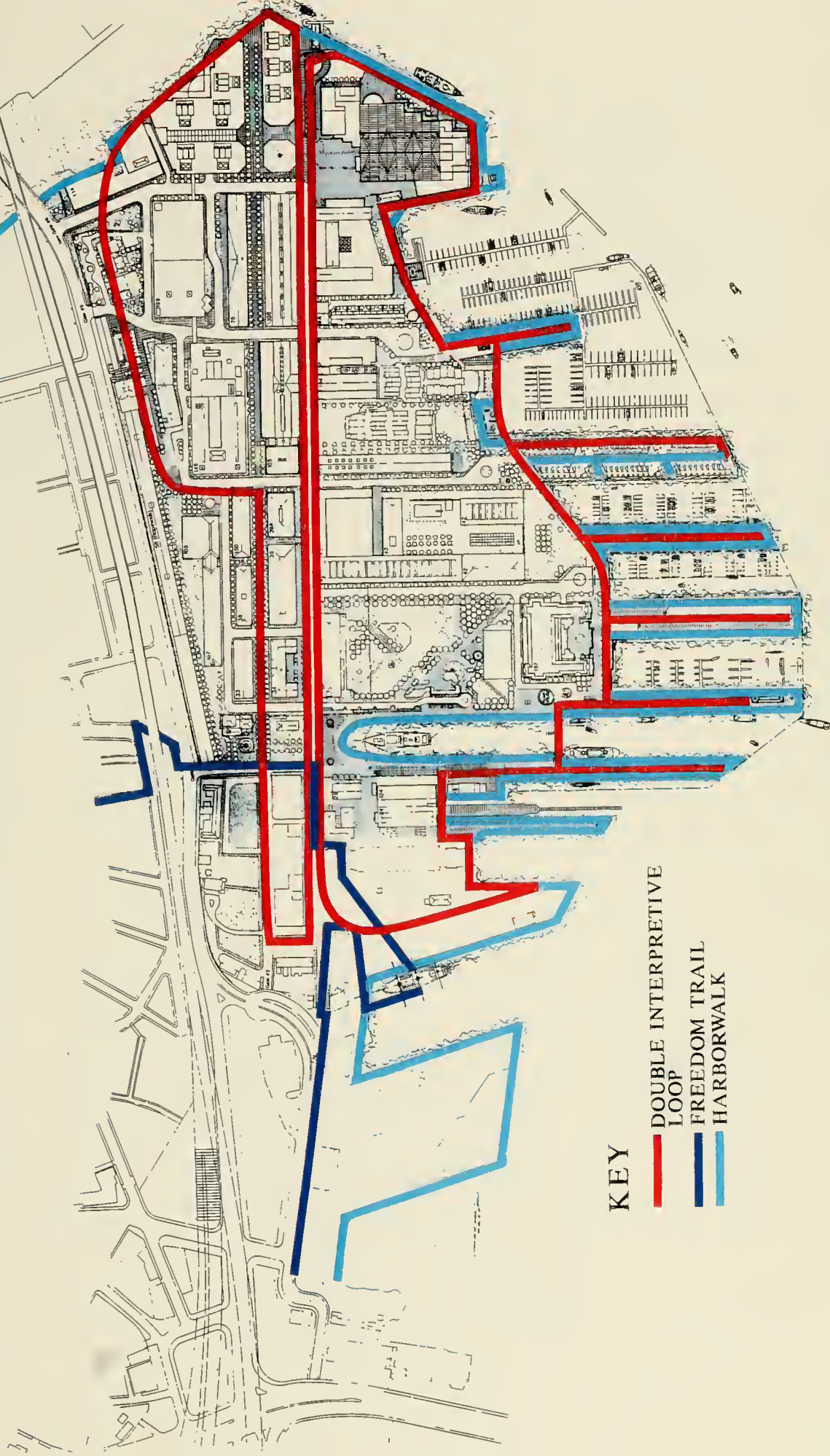
- o The Freedom Trail, which is a three mile walking trail connecting 16 historic sites located in three city districts. Designed during the 1950's the trail's primary focus is the presentation of sites with relevance to the colonial era. Heavily traveled, the Freedom Trail is the primary system through which tourists experience the city.
- o Harborwalk, which is designed to strengthen public access to the waterfront, provides for a diversity of uses along the waters edge. These include parks, promenades, water shuttle terminals and public landings. Intended to traverse the city's entire shoreline, Harborwalk will serve as an important pedestrian connection to the downtown.

The Double Interpretive Loop, the Freedom Trail and Harborwalk all join at the Charlestown Navy Yard. This highly visible intersection is also the entry to the National Historical Park. It is crucial that the potential of this significant location be appropriately realized.

The Double Interpretive Loop builds upon the dynamic relationship which will be created between the proposed New England Aquarium at Drydock #5 and the U.S.S. Constitution at the other end of the Charlestown Navy Yard. A series of informational and wayside exhibits will inform people whose primary trip purpose is the New England Aquarium about additional attractions available at the Navy Yard, and direct them along First Avenue toward the U.S.S. Constitution. Visitors whose primary destination is the U.S.S. Constitution will likewise be informed about and directed along First Avenue to the New England Aquarium. The Chain Forge Building 105, midway between the two major attractions, is envisioned as a significant historic/interpretive focus along the Double Interpretive Loop featuring the enormous chain forge presses that were used to manufacture anchor chain for the Navy.

On their return journey from either the New England Aquarium or the U.S.S. Constitution, visitors will have two options. A continuous water's edge walkway is proposed to include wayside exhibits interpreting significant historic resources including shipways, shiphouses, drydocks, pump houses, piers and the marine

CHARLESTOWN NAVY YARD MASTERPLAN



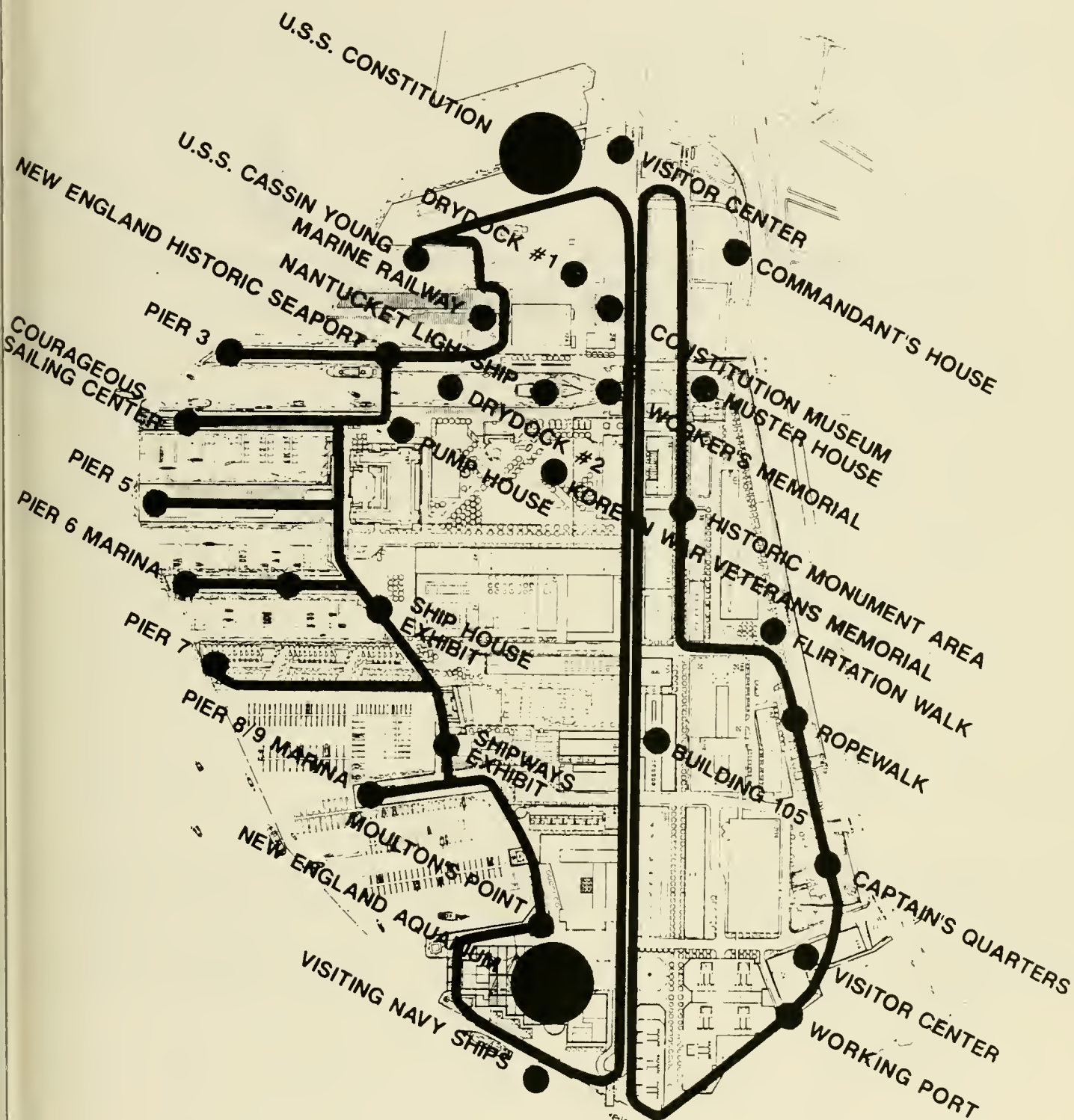
KEY

- DOUBLE INTERPRETIVE LOOP
- FREEDOM TRAIL
- HARBORWALK

railway. Industrial artifacts such as light gantries will also serve as destination points to draw people to the ends of piers.

A landward return loop is proposed to include interpretation of the Commandant's House, the octagonal Muster House, and the Captain's Quarters Area, as well as a significant center within the Ropewalk complex. Flirtation Walk and many other groundplane improvements originally conceived at the time of initial transfer in 1978 will become integral elements of the Double Interpretive Loop.

The accompanying plan identifies potential interpretive sites along the Double Interpretive Loop that have emerged in discussions to date. It is not intended as a final plan, but rather to set the stage for detailed design and refinement as further described in the Plan for the Plan.



4

PLAN FOR THE PLAN

PLAN FOR THE PLAN

The Double Interpretive Loop is a complex undertaking with tremendous potential. It is not something that can be brought to fruition by any one party. Full realization requires continued effort by all parties who have been involved in the evolution of the concept to date. Staffing and managing this effort will be a critical aspect in assuring success. Accordingly, the BRA is committed to provide the resources and staff necessary to coordinate this effort towards achieving the goal of implementing the Double Interpretive Loop on a contemporaneous schedule with the remainder of the Charlestown Navy Yard buildout.

The accompanying schedule and scope of work lays out a "Plan for the Plan" that details the next steps which will be undertaken. It provides for full participation of local, state, and federal preservation officials in order to achieve the concerted effort that will be required to bring the Double Interpretive Loop concept to reality in a manner which satisfies all involved parties.

In addition, specific descriptions of potential development for five sites along the Double Interpretive Loop are provided. These sites -- Flirtation Walk, a Wayside Exhibit at the Shipways, the Ropewalk Complex, the Chain Forge Building 105 and the Shipyard Workers Monument -- serve to illustrate the range of elements envisioned. The specific site descriptions are also proposed as examples of the type of description that will be developed for each of the other components of the Double Interpretive Loop in continuing discussions with historic preservation officials.

The Double Interpretive Loop concept has struck a responsive chord amongst a wide range of interests. This is clearly evident from its reference in numerous letters commenting on the Charlestown Navy Yard Draft Supplemental Environmental Impact Report, June 1991.

To provide an effective forum for further input and suggestions formation of an advisory committee may be advantageous. In addition to historic preservation officials, this committee could include historic/cultural organizations within the Yard as well as representatives from the Charlestown community and waterfront advisory groups.

A. PROPOSED SCOPE AND SCHEDULE

A National Historic Landmark, the Boston Naval Shipyard at Charlestown is meaningful in a variety of contexts. As a landscape which has changed throughout time, the Navy Yard contains many remnants of the past. These remnants tell the story of the significant natural and man made features which over time have created the place which is today the Charlestown Navy Yard - a special site with a rich overlay of history contained within an active evolving urban context.

The creation of an interpretive program within the Navy Yard will bring to the surface the rich palimpsest of historical information which today is only partially revealed. Designed to link the Navy Yard's two key attractions, the USS Constitution and the New England Aquarium, the Double Interpretive Loop will present, in readily understandable terms, the evolution of the site. The information will be displayed in a coherent and engaging format.

To facilitate the creation of the Navy Yard Interpretive Loop, the following scope of work is proposed. This scope provides an opportunity for the thoughtful combination of a serious research project coupled with the creative talents of interpretive exhibit designers and/or graphic designers to translate the information into a comprehensive and comprehensible system. In summary, the scope encourages the creation of a system which:

- o Provides interpretive materials that detail the evolution of the site from before settlement to the 1990's;
- o Ties the history of the Charlestown Navy Yard to the history of the City of Boston as well as the New England region and the developing nation;
- o Represents the perspective of being in the Navy Yard within a broad spectrum of individual histories and narrations;
- o Is designed to be of interest to different age groups;
- o Unveils clues to the hidden landscape through the design of innovative informational/interpretive exhibits and/or signage and a walking guide.

The project will be divided into three phases. The first phase, program development, will provide the historic documentation for the second phase, interpretation. Phase three involves implementation.

Phase One: Program Development

The careful creation of the development phase of a project is crucial in developing the framework for its success. For the proposed interpretive system being created within the Charlestown Navy Yard there are many important and difficult tasks which will need to be completed during this phase.

Establishing an identity and scope for the project will be one of the primary goals of the program development phase. This task will include everything from deciding an appropriate name for the system (trail, walk, tour?) to hiring appropriate consultants to assist in the program's definition. The system through which decisions are made will be outlined, as will the parties who will make those decisions. The program will begin to take form and become a more identifiable entity.

Parallel to the creative process of defining the program is the more mundane chore of information gathering. These two tasks can occur simultaneously providing there are clearly established resources for the location of such materials. It is during the analysis phase, when the developed program synthesizes all of the information that has been researched that a clear outline can evolve.

It is estimated that all of the items during the development phase can be completed within 6 months.

A. Evaluation

1. Research photographic, written, and oral documentation and artifacts of the Navy Yard throughout time, including relevant data pertaining to the sites natural history, as well as early settlement patterns, colonial history, and naval and industrial history.
2. Create hierarchy of significant events and individuals related to the Navy Yard, e.g., via a time chart of the site's evolution.
3. Research data relating events in the Navy Yard within the broader context of American experience.
4. Research relevant data relating events in the Navy Yard within the development of the city of Boston, including, but not limited to, existing historic sites and interpretive elements.

B. Analysis

1. Compile a comprehensive landscape history of the Charlestown Navy Yard.
2. Create an outline of sites within the Yard, ranked in

order of their significance, which merit interpretation.

3. Link the proposed sites to the hierarchy of significant events and individuals.
4. Overlay proposed interpretive concepts with the path system proposed in the CNY DSEIR.
5. For each interpretive concept approved for inclusion in the loop provide text and all necessary illustrative data needed to successfully interpret the site.

Phase Two: Interpretation

After a program is developed the actual components of that program can be designed. It is in this phase that the "vision" of the project is taken from rhetoric and transformed into a tangible form.

The interpretive phase of the project will be the phase in which a signage consultant or designer of interpretive systems will be brought into the project. It will be important to explore different visual possibilities for the program and experiment with appropriate technologies, design themes and program components. A hierarchy of appropriate physical materials will be developed during this phase as will site locations.

Transforming an idea into a concrete form can be a lengthy and exhaustive process. Any necessary design reviews and all applicable approvals must be obtained during this phase. Assuming such approvals are obtained in a timely fashion, successful completion of this phase is anticipated in 6 months from completion of phase one.

A. Analysis

1. Review all relevant signage to the project including, but not limited to Harborwalk, the Freedom Trail, and the Charlestown Navy Yard Master plan.
2. Review and evaluate proposed interpretive sitings.

B. Design Development

1. Develop a consistent design theme that could be used to develop an interpretive system in the Navy Yard.
2. Create an information system, based on the theme from task 1 for the interpretive program including, but not limited to signs, informational markers, exhibits, and

maps. Provide no less than three alternative designs in full color, and materials for review. Present the designs in a series of formal presentations illustrated by 35 mm slides. The presentation will include a detailed explanation of the rationale for the designs and how each relates to the system as a whole.

C. Implementation Strategies

1. Prepare detailed site descriptions for each component of the Double Interpretive Loop that summarize program elements to be provided at each site and agreed upon implementation strategy.

Phase Three: Implementation

The final step in completing the program will be to physically construct and install the signage/interpretive exhibits. This is foreseen as an ongoing process which will occur over the course of the Navy Yard buildout.

A schedule will be set during this phase for the installation of the interpretive materials.

A. Signage-wide Elements

1. Provide an overall sign schedule keying each sign to site location. Prepare detailed drawings and specifications for each type of signage element. Supervise fabrication and installation of mock-ups.
2. Prepare overall marketing strategy, design brochure mock-ups and upon approval contract for printing.

B. Exhibits/Interpretive Sites

1. Prepare Requests for Proposal for sites to be advertised for redeveloper interest.
2. Prepare guidelines for sites to be part of current developer designations within the Navy Yard or through participation of other parties.

B. EXAMPLE SITE DESCRIPTIONS

The following detailed descriptions of Flirtation Walk, a Wayside Exhibit at the Shipways, the Ropewalk Complex, and Chain Forge Building 105, and the Shipyard Workers Monument are intended to illustrate the range of interpretive elements envisioned along the Double Interpretive Loop. These examples are provided as a point of departure for further input towards detailed design and implementation.

Similar detailed descriptions are also proposed to be developed for each of the other components of the Double Interpretive Loop over the course of further discussions with historic preservation officials. The plan development phase will thus result in specific implementation strategies for all elements of the system thereby assuring overall coherence and integrity.

1. Chain Forge Building 105

A significant interpretive focus is envisioned within Building 105 that features the immense chain forge equipment still extant in the shed portion of the structure. Overall building treatment will be in accordance with the Program of Preservation and Utilization.

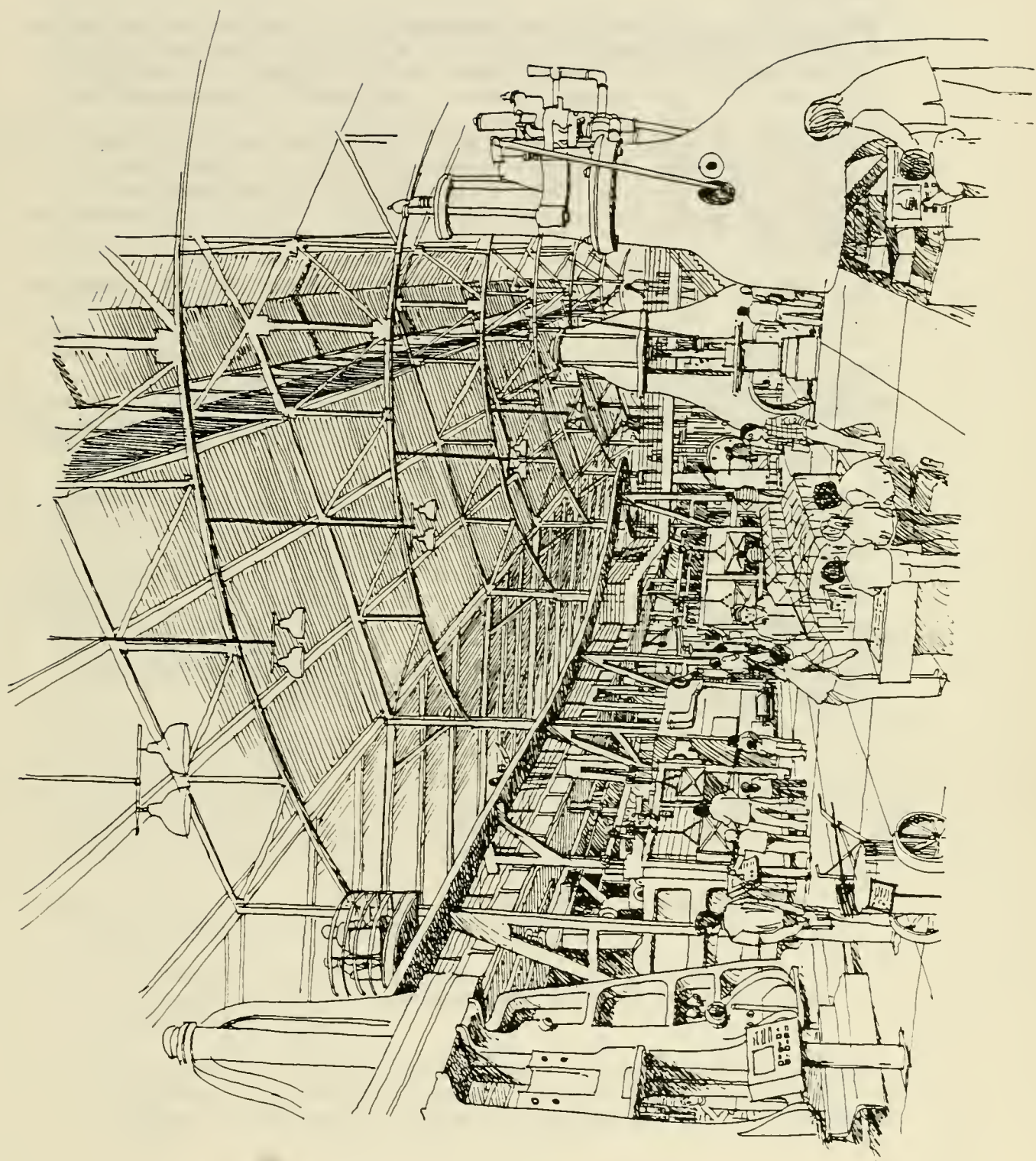
Redevelopment will be accomplished by solicitation of redeveloper interest through a Request for Proposals ("RFP"), which includes specific design and development guidelines for the project. The BRA will prepare and submit Draft RFPs for MHC, DOI, BLC, and NPS comment and approval.

In order to advance the discussion, a range of development alternatives have been prepared for review with historic preservation officials. These include:

- A) Straightforward, simple restoration of the entire structure to provide an adequate level of public safety and allow visitors to experience the industrial character of the chain forge equipment within the entire spatial envelope of the current shed structure.
- B) Rehabilitation of the headhouse of Building 105 for commercial uses, and straightforward restoration of the shed as described under Alternative A above.
- C) Accommodation of commercial re-use in both the headhouse and shed structure within the parameters established in the prior RFP for Building 105, released in 1986.
- D) Maximum accommodation of commercial re-use within broader parameters for location of industrial artifacts within the structure.

This broad range of alternatives has been developed in response to the inability to achieve the development program described under Alternative C during the past five years. In fact, "less is more" may prove to be most appropriate for Building 105. Given the extraordinary constraints imposed on construction of commercial space by the existing structure and achievement of historic preservation goals, each incremental square foot of space could easily cost more than it can generate in return. The financial gap could thus widen rather than shrink upon the addition of commercial space within this development. In addition, the overall economic demand for re-use of historic structures has obviously diminished since 1986.

On the other hand, less extensive commercial re-use of this structure creates the potential for an interpretive element



that does not seek to "polish" the exhibits, but rather maintains the gritty, industrial appearance of the chain forge presses. An audio-visual component which conveyed a sense of the power and fury of this industrial operation could be a natural complement to such an interpretive approach.

Financial analysis of the development alternatives suggests that the entire range generates a shortfall or gap. In other words, total development costs exceed the value generated by projected income. The BRA is committed to identifying and structuring gap financing strategies to bridge this shortfall and insure that re-use of Building 105 is accomplished. The RFP process can most effectively advance this goal through competitive solicitation of proposals based on gap minimization as one of the selection criteria.

The BRA has contracted with a museum consultant to provide additional input on fiscal, operational, and design implications of the various options for Building 105. The next steps involve bringing such expertise to bear, integrating comments of local, state, and federal preservation interests, and finalizing an RFP for review and approval. It is anticipated that this can be accomplished within six months.

In the meantime, MHC, BLC, and DOI have signed off on the Stabilization Plan for Building 105, and the BRA is now preparing contract documents to execute the work. Advertisement of the stabilization contract is anticipated during the fourth quarter of this calendar year. Such work will ensure that deterioration of this historic structure will be arrested in anticipation of its subsequent preservation and incorporation as a significant element along the proposed Double Interpretive Loop.

2. Flirtation Walk

In 1823, Commodore William Bainbridge planted more than 200 elm trees throughout the Navy Yard, in the first significant effort to landscape the facility, which still bore much of the appearance of its former use as a pasture. Since that time, the Yard's network of open spaces has been worked and reworked, in response to many different functional and aesthetic considerations.

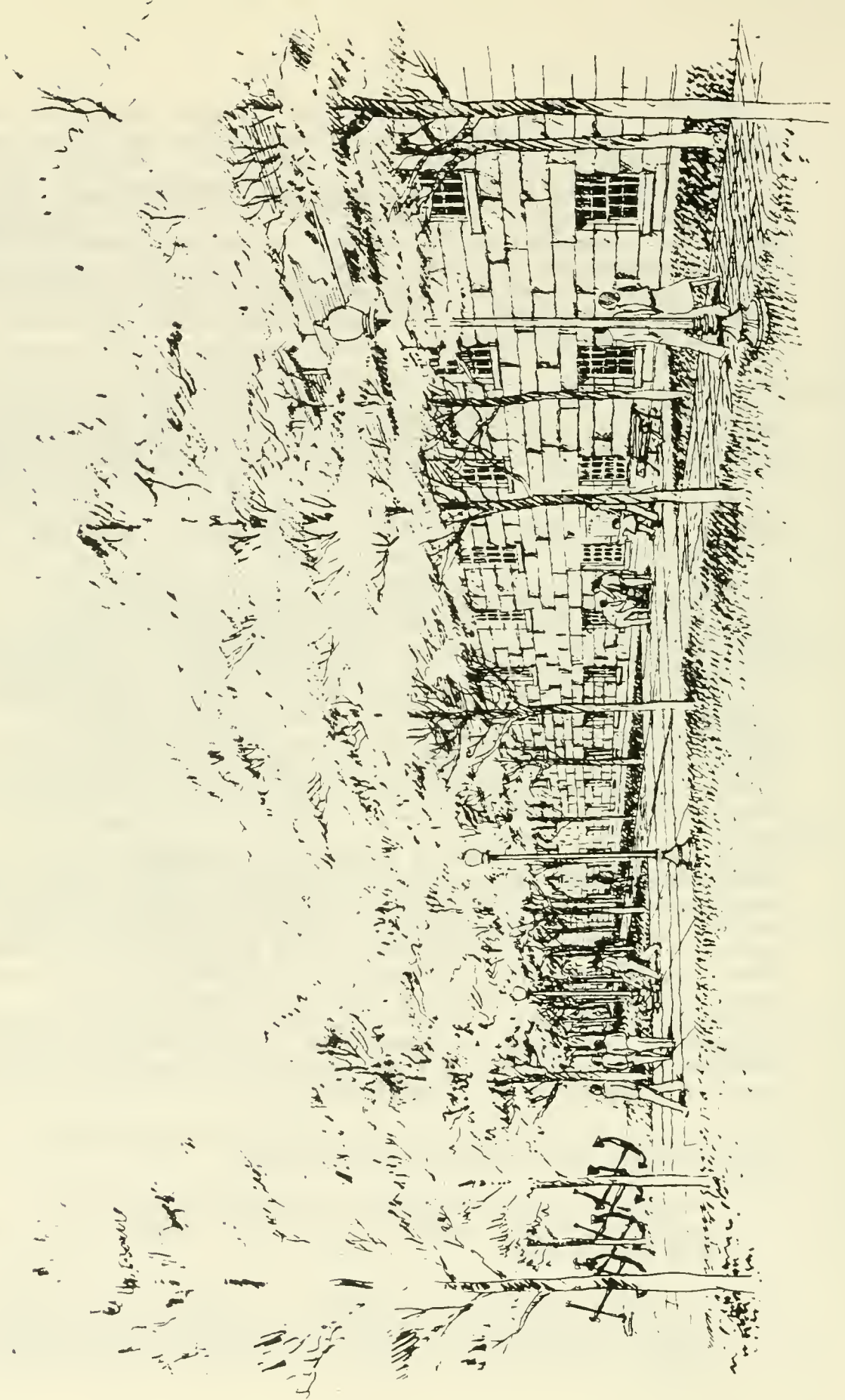
As the nineteenth century wore on, the maturing elms lining the streets, the familiar parade grounds, and the anchor and gun shot parks acquired a picturesque quality duly noted by visitors. The shipyard grounds were open to visitors every day except Sunday, and the residents of Charlestown came to picnic, promenade along the elms and enjoy the Commandant's famous garden, complete with its ornamental trees and flowering shrubs.

The Ropewalk complex (Building 58), which had been constructed in the 1830s, sponsored one of the shipyard's most important functions -- the manufacture of rope for the entire U.S. Navy fleet. In fact, the Master Ropemaker was at one time the Yard's highest paid worker. More than a quarter mile long, the granite Ropewalk dominated the northwestern boundary of the Yard. Paralleling the Salem Turnpike (now Chelsea Street), it was one of the few buildings not aligned with the regimented grid geometry of the 1828 Master Plan.

Until the 1870s, the space between the Ropewalk and Buildings 33 and 38 was an open, grassy field. It was used as an open-air storage area for ammunition and ship anchors and was called, appropriately, Anchor Park and Gun Shot Park. A boardwalk (later changed to brick paving), passing this area and running alongside the Ropewalk for its entire length, came to be known as "Flirtation Walk" (or "Flirtation Alley"). Flirtation Walk was lined by a double row of elm trees and punctuated by gas lights and occasional benches. By the 1880s, it was known as a romantic spot for evening promenades on moonlit nights.

The role of a restored Flirtation Walk in the Double Interpretive Loop concept is threefold:

1. Provide a safe, attractive and fully accessible pedestrian route between the Gate 4/ Muster House area and Yard's End;
2. Provide visibility and access to the proposed Ropewalk Museum, including a possible exhibit at the Tarring House (Building 60) which is adjacent to the Ropewalk; and



3. Develop a sequence of interconnected, pleasant, green spaces incorporating historic artifacts, seating areas and wayside exhibits which tie into the overall open space network proposed for the Yard.

The Flirtation Walk component of the Double Interpretive Loop is envisioned as a more passive and contemplative activity generator than the waterside attractions. However, imaginatively designed exhibits employing various media and appropriately arranged historic Navy artifacts will surely enrich the experience of visitors of all ages.

3. Ropewalk and Tar House

The Ropewalk Building 58 and Tar House Building 60 are among the most highly significant historic structures within the Charlestown Navy Yard. The Ropewalk which is over 1/4 mile in length is the last remaining masonry ropewalk building in the entire country.

The Boston Landmarks Commission ("BLC") has been petitioned to designate the Ropewalk as a Boston landmark. In its report to the Commission, BLC staff recommends such designation for the building's exterior and certain portions of the interior. The Ropewalk was also added to the National Historical Park by Act of Congress in 1978. However, Congress did not appropriate funds to acquire and rehabilitate this unique structure.

The Ropewalk's extraordinary length and relatively remote location within the Navy Yard constrains redevelopment. Low first floor height and small window area creates additional complications.

The Boston Redevelopment Authority nevertheless remains committed to achieve re-use of the Ropewalk and Tar House. A significant museum/interpretive component is envisioned as part of the overall redevelopment program to create an important focus along the Double Interpretive Loop.

A number of proposals have been brought forward in the past to rehabilitate the Ropewalk for museum and cultural uses. Unfortunately these proposals have foundered, in part no doubt because of the magnitude of investment required to undertake such re-use of the entire structure. Accordingly, the following strategy is proposed for consideration.

Redevelopment of the Ropewalk will be accomplished by solicitation of redeveloper interest through a Request for Proposal ("RFP"), which includes specific design and development guidelines for the project. The BRA will prepare and submit Draft RFPs for MHC, DOI, BLC and NPS comment and approval.

Interestingly, notwithstanding the pervasive length, the Ropewalk can be differentiated into four relatively distinct elements with quite different attributes. The development potential of these distinct elements could vary significantly as indicated in the accompanying chart. Thus, to secure the broadest possible redeveloper interest, the RFP should be structured to encourage proposals not only for the entire structure but also for portions of the Ropewalk.

The benefits of this approach are twofold. First, the potential for cross-subsidy from for-profit uses to the presumably not-for-profit museum/cultural component can be

enhanced as each participant will be responsible for just that area in which they have expertise. Secondly, the entire Ropewalk Complex can be redeveloped in a phased schedule which significantly lowers the investment hurdle that has frustrated prior re-use concepts.

The National Park Service has indicated a preference that 20-25,000 square feet of space devoted to museum/cultural interpretation of ropemaking be provided within the Ropewalk. Accordingly, the BRA has prepared two alternatives that accommodate such program for further discussion with historic preservation officials:

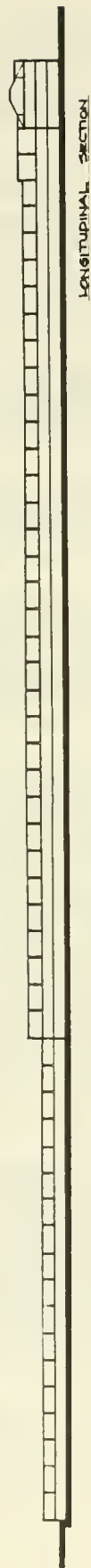
- A. A 20-25,000 square foot museum/cultural program on the first floor of the Ropewalk Complex between the Head House and the proposed Anchor Park at 13th Street;
- B. A 20-25,000 square foot museum/cultural program within the two story portion of the Ropewalk immediately adjacent to the Head House.

Either of the scenarios could accommodate both phased development as well as multiple redeveloper interest. To enhance coordination amongst potential multiple redevelopers the RFP could specifically encourage joint ventures between for-profit and non-profit entities.

The Tar House is envisioned for museum/cultural re-use under both alternatives. Inasmuch as the Head House of the Ropewalk appears to present the most promise for commercial redevelopment, both scenarios also accommodate such re-use.

The BRA has contracted with a museum consultant to provide additional input on the fiscal, operational and design implications of the re-use of the Ropewalk and Tar House. The next steps involve bringing such expertise to bear, integrating comments of local, state and federal preservation interests and finalizing an RFP for review and approval. It is anticipated that this can be accomplished within six months.

In the meantime, MHC, BLC, and DOI have signed off on the Stabilization Plan for the Ropewalk Building 58 and the Tar House Building 60, and the BRA is now preparing contract documents to execute the work. This will insure that any potential further deterioration of these structures will be arrested in anticipation of their subsequent preservation and incorporation as significant elements of the proposed Double Interpretive Loop.



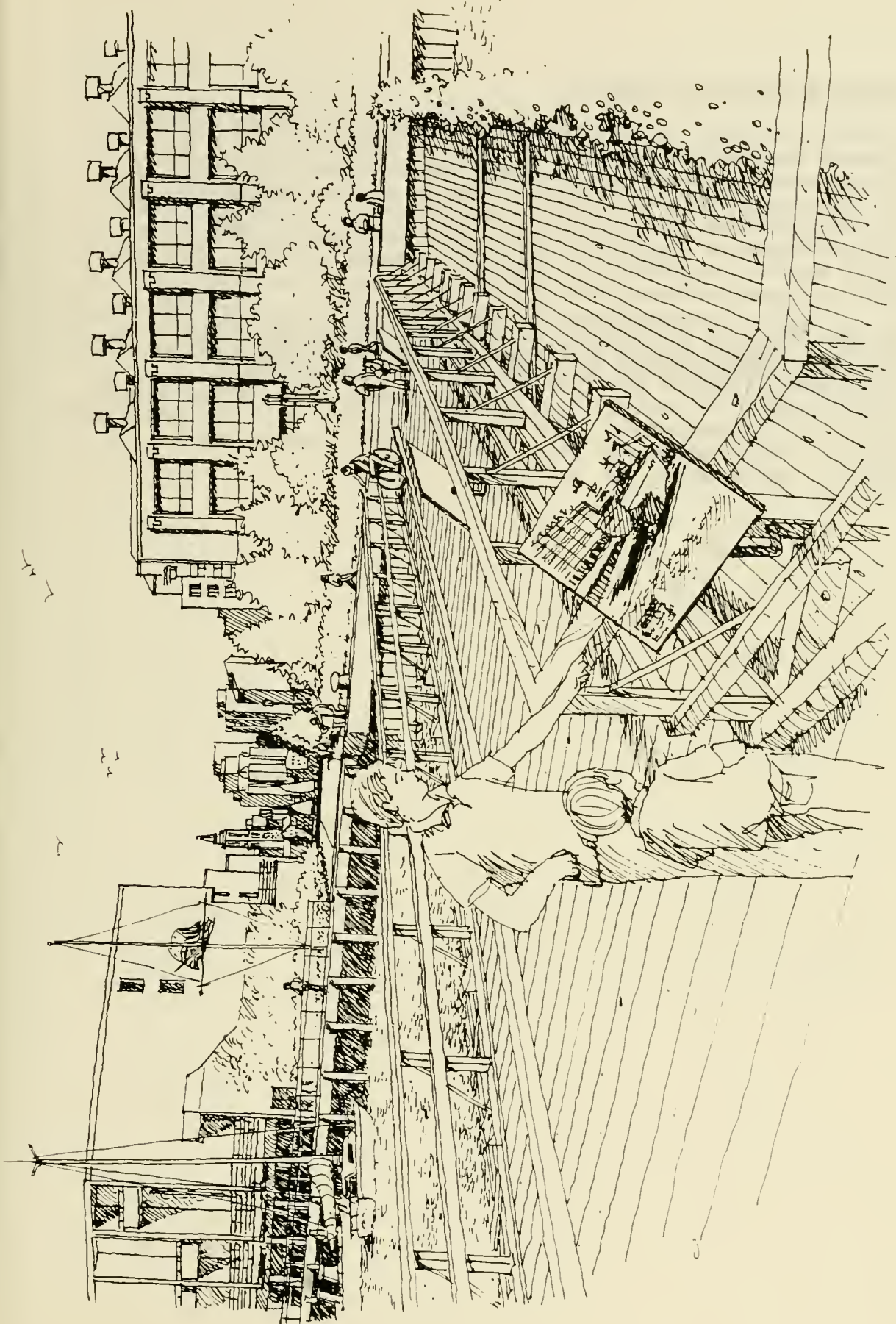
| SECTION 1 | | SECTION 2 | | SECTION 3 | | SECTION 4 | |
|-------------------------|---|---|--|---|--|-----------|--|
| PEDESTRIAN ACCESS | 2 ENTRANCES; EASILY ACCESSIBLE FROM GATE 5
POTENTIAL ACCESS FROM CHELSEA ST. AT BLDG 79 | ROPEWALK: 1 ACCESS POINT ON SOUTH SIDE
TAR HOUSE: 3 ACCESS POINTS ON NORTH SIDE | ADADEQUATE ACCESS FROM 9TH ST
INCONVENIENT ACCESS BEHIND BLDG 107 | 3 ENTRANCES; EASILY ACCESSIBLE FROM GATE 4,
3RD STREET & FLIRTATION WALK | | | |
| | TWO INCONVENIENT ACCESS FROM 4TH AVE DROPOFF AREA
UNSUITABLE DROPOFF AREA ON 13TH ST AT GATE 5 | ACCESSIBLE FROM 4TH AVE DROPOFF AREA | ACCESSIBLE FROM 4TH AVE DROPOFF AREA | OPPORTUNITY FOR DROPOFF AT 3RD ST & 3RD AVE | | | |
| PARKING | CONVENIENT TO BLDG 199 GARAGE | CONVENIENT TO BLDG 199 GARAGE | POTENTIAL ADDITION OF BELOW-GRADE PARKING
AT CONVERTED BLDG 108 | REMOTE TO PARKING FACILITIES, YET CONVENIENT
TO PUBLIC BUS AND SHUTTLES | | | |
| VISUAL CORRIDORS | VIEWS FROM PROPOSED FLIRTATION WALK & 13TH ST | VIEWS FROM PROPOSED FLIRTATION WALK AND WITH
APPROPRIATE SIGNAGE FROM 13TH ST & 4TH AVE | FLIRTATION WALK, 9TH ST, 4TH AVE | GATE 4, 3RD ST, DRYDOCK 2/SBPIER PARK | | | |
| | VIEWS OF COMMON AREA DEFINED BY
BLDG 62, 79, 96 & HEAD HOUSE | MUSEUM SPACE VIEWS NOT RELEVANT | OPEN SPACE DEFINED BY
BLDG 62, 107, 108 & TAR HOUSE | FLIRTATION WALK & OPEN SPACE DEFINED BY
BLDG 31, 33, 107 & 120 | | | |
| BUILDING CONDITIONS | REHABILITATED | REHABILITATED | BLDG 108 IS RUNDOWN
BLDG 107 IS IN POOR CONDITION | BLDG 31, 33 & 120 ARE REHABILITATED
BUILDING 107 IS IN POOR CONDITION | | | |
| | OCCUPIED OFFICE | OCCUPIED OFFICE | BLDG 108 IS VACANT
BLDG 107 IS USED BY NPS | BLDG 31, 33, 120 ARE OCCUPIED OFFICE
BUILDING 107 IS USED BY NPS | | | |
| SURROUNDING ENVIRONMENT | PUBLIC PLAZA DEFINED BY
BLDG 62, 79, 96 & HEAD HOUSE | PUBLIC PLAZA DEFINED BY BLDG 62, 79, 96 &
ROPEWALK/TAR HOUSE
FLIRTATION WALK &
SPACE BETWEEN BLDG 62 & TAR HOUSE | OPEN SPACE DEFINED BY
BLDG 62, 107, 108 & TAR HOUSE | FLIRTATION WALK AND OPEN SPACE DEFINED BY
BLDG 31, 33, 107 & 120 | | | |
| | SUITABLE | NOT SUITABLE DUE TO MACHINERY | SUITABLE | SUITABLE | | | |
| OFFICE | SUITABLE | SUITABLE | SUITABLE | SUITABLE | | | |
| MUSEUM | SUITABLE | SUITABLE | SUITABLE | SUITABLE | | | |
| FLOOR LAYOUT | | 1ST FLOOR HAS MACHINERY
2ND FLOOR IS CONTINUOUS, FLEXIBLE SPACE | CONTINUOUS, FLEXIBLE SPACE ON SECOND FLOOR
1ST FLOOR HAS RAIL TRACKS | ONE CONTINUOUS, FLEXIBLE SPACE
YET RAIL TRACKS ACROSS FLOOR | | | |
| SP | | | | | | | |
| CIRCULATION | STAIRCASE NORTHWEST SIDE
ELEVATOR ADJACENT TO NORTHEAST ENTRANCE | POOR VERTICAL CIRCULATION; 1 STAIRCASE ON
WEST SIDE & 2 FIRE EXITS ON 2ND FLOOR | POOR VERTICAL CIRCULATION; 1 STAIRCASE ON
WEST SIDE & 2 FIRE EXITS ON 2ND FLOOR | ONE FLOOR | | | |
| | (1) 9'6" / (2) 11'3" / (3) 10'6" (4) STORAGE | (1) 9'6" / (2) 11'3" / (3) 10'6" (4) STORAGE | (1) 9'5" (2) 10'7" | (1) 9'5" (2) 10'7" | | | |
| CEILING HT | POTENTIAL SKYLIGHT ON SOUTH SIDE | POTENTIAL SKYLIGHTS | POTENTIAL SKYLIGHTS | POTENTIAL FOR SKYLIGHTS | | | |
| SKY LIGHTS | | | | | | | |

4. Wayside Exhibit at Shipways

The Shipways ramps, constructed of reinforced concrete and wood, were built in 1920 (Shipways One) and 1945 (Shipways Two). The ramps now form the foundation of the residential structures in this area and are the reason for their stepping down toward the harbor. The restored bridge walkway was built after the cessation of intensive war efforts eliminated the need for the ramps. Remnants of the wooden waterside portion are visible; the ramp of Shipways Two is still visible below the bridge, plunging into the water; the cutoff edge of the Shipways One ramp is visible in the wall just below the lawn area near the westerly portion of the walkway. Support pile remnants are also visible at low tides.

The Wayside Exhibit at the Shipways site could be envisioned as a series of etched metal panels showing the changes in piers and bulkheads over the years as the U. S. Navy constantly upgraded or adapted the Navy Yard facilities for its evolving role as a major research and industrial yard for the also evolving U.S. Navy. Also depicted could be the old wooden shipbuilding sheds, huge barnlike structures which allowed for the first time year-round work on all aspects of shipbuilding, and which can be found in old prints and photographs

The technical aspects of the Shipways ramps, illustrated by a diagram of their construction and use, and a photograph or print of a ship on one of the ramps could be composed into appropriate interpretive panels located where the ramps are most visible. The innovative shipbuilding sheds could also be discussed in terms of their importance to production scheduling.



5. Shipyard Workers' Monument

In 1990, a group of retired former Charlestown Navy Yard workers approached the BRA to consider dedicating a statute to commemorate the men and women who had been employed in the construction and repair of ships in Charlestown since the early 1800s. The head of Drydock #2, was identified as an advantageous location for appropriate public art that would depict the contributions of workers over the 174 years that the Charlestown Navy Yard was a naval installation.

The BRA intends to submit an application to the Edward Ingersoll Browne Fund for a design services grant which will allow the Shipyard Workers Monument to move toward realization. A Request for Qualifications for artists will be issued subsequently. It is anticipated that the BRA will seek Browne Fund monies for implementation along with private assistance, if necessary.

5

REFERENCES AND RESOURCES

REFERENCES AND RESOURCES

The following have been prepared in order to provide references and resources for further development of the Double Interpretive Loop:

- A. Annotated Bibliography --
Charlestown Navy Yard
- B. Photographic Sources --
Charlestown Navy Yard
- C. Signage and Interpretive Programs --
Boston And Charlestown Navy Yard
- D. Example of other Interpretive Plans

A. ANNOTATED BIBLIOGRAPHY -- CHARLESTOWN NAVY YARD

Bearss, Edwin C. Historic Resource Study, Charlestown Navy Yard, 1800-1842, Boston National Historical Parks (Volumes I and II). Denver: U.S. GPO, October 1984.

An exhaustive resource study detailing the history of the Navy Yard from its authorization through August 1842, when the Board of Naval Commissioners (which oversaw day-to-day operations of the Navy) was abolished. The narrative is supplemented by a series of historical base maps.

Black, Frederick R. Charlestown Navy Yard, 1890-1973 (Volumes I and II). Boston: Boston National Historical Park, National Park Service, U.S. Department of the Interior, 1988.

A comprehensive narrative detailing the history of the Navy Yard during what could be called its modern era. The historical information is informed by numerous references to developments in the United States Navy.

Brockway, Lucinda A. and Patrice A. Todisco. Charlestown Navy Yard: Historic Grounds Management Report, prepared for National Park Service, Boston National Historical Park. Boston: 1985.

An illustrated report documenting the changes to the Navy Yard landscape that have occurred since 1976, supplemented with historical background information. Recommendations for restoration are included.

Cochran, Samuel J. "Reminiscences of the Boston Navy Yard - Boston - By an Old Employee," March 14, 1917.

A colorful and informally written narrative describing mid-19th century conditions at the Navy Yard.

Larson, Leslie. History of the Charlestown Navy Yard, prepared for the Boston Redevelopment Authority.

A detailed history of the Navy Yard, discussing significant persons, important buildings, and notable ships built or repaired at Charlestown.

Larson, Leslie. The Ropewalk at the Charlestown Navy Yard: A History and Reuse Plan; prepared for the Boston Redevelopment Authority, December 30, 1987.

A detailed history and description of the Ropewalk complex, the Navy Yard's most historically significant grouping of structures. The report incorporates background information on early Boston ropewalks. Supplementing the history, Mr. Larson proposes a museum, historical research, and archives facility reuse for the complex.

National Park Service. Boston Naval Shipyard, Architectural and Environmental Inventory. Compiled by David Wright. Boston: 1974.

A compilation of historical information about many Navy Yard buildings, from Navy Department archives. Drawings and photos are referenced.

Norton, Bettina A. The Boston Naval Shipyard, 1800-1974; A Bostonian Society Picture Book. Reprinted from the Proceedings of the Bostonian Society Annual Meeting, 1974. Boston: Bostonian Society, 1975.

An informative history describing the technological achievements and important personalities associated with the Navy Yard as well as its significant buildings.

Shettleworth, Earle G. and Roger G. Reed, ed. A Biographical Dictionary of Architects in Maine, Alexander Parris, 1780-1852. Vol. IV, No. 1. Augusta, Maine: Maine Historic Preservation Commission: 1987.

A monograph describing the career of Alexander Parris, particularly his military and residential commissions in Maine and elsewhere.

U.S. Department of the Interior, National Park Service. Boundary Enlargement Report, Charlestown Navy Yard. Denver: 1978.

This report is supplemented by historical background information. A copy of the National Register of Historic Places Nomination Form is appended.

_____. National Historic Landmark Boundary Study (Draft), February 1986.

A draft containing much useful historical information about Navy Yard buildings.

. Survey of Historic Sites and Buildings in States
Located East of the Mississippi, Volume III, Commerce and
Industry. The National Survey of Historic Sites and
Buildings. 1966.

An historical summary emphasizing historic ships associated
with the Yard.

Taylor, Margaret McD. Buildings That Last: Parris in Boston.
Booklet funded by a grant from the Massachusetts Foundation
for Humanities and Public Policy. Boston: 1981.

A celebration of Alexander Parris and his work; companion to
an exhibit created by Ms. Taylor, entitled "Parris in
Boston."

B. PHOTOGRAPHIC SOURCES -- CHARLESTOWN NAVY YARD

1. Public Collections

- o National Park Service Archives, Building 107, CNY
Contact: Mr. Arsen Charles
- o The Bostonian Society, 15 State Street, Boston
Contact: Mr. Philip Berger, Librarian
- o Boston Public Library, 666 Boylston Street, Boston
Contact: Rare Book Librarian
- o Society for the Preservation of New England Antiquities
(SPNEA), 141 Cambridge Street, Boston
Contact: Ms. Lorna Condon

2. Private Collections

- o Retired CNY Workers
Contact: CNY Workers Monument Committee

C. SIGNAGE INTERPRETIVE PROGRAMS -- BOSTON and CHARLESTOWN NAVY YARD

There are currently three signage programs in various phases of development -- the Freedom Trail Signage Master Plan, the Charlestown Navy Yard Signage Program, and the Harborwalk Sign System -- which intersect with an eventual historic trail in the Yard. They are very different in scope and intent from each other, yet share the common goal of providing information while reinforcing the identity of distinct pedestrian experiences.

Both the Harborwalk and the Freedom Trail signage studies go beyond the boundaries of the Charlestown Navy Yard. Harborwalk ties the Navy Yard to its waterfront and celebrates the relationship of land to sea. The Freedom Trail unites the Navy Yard to the historic downtown and Charlestown communities. It is associated closely with the city's Colonial past.

Signage for both Harborwalk and the Freedom Trail is in the schematic phase of development. Both systems are multi-faceted and envision the use of directional, informational and possibly interpretive materials.

The signage which is currently being studied for the Charlestown Navy Yard will be used within the boundaries of the Yard itself. Designed to fill a functional need for information about how to get around within the Navy Yard, this signage will identify parking garages, street locations and individual buildings and attractions.

The following describes these three programs in more detail to set the broader context within which the Double Interpretive Loop will be accomplished. The benefit of more detailed thinking about Navy Yard Signage is also provided as a starting point.

1. Freedom Trail Signage Master Plan

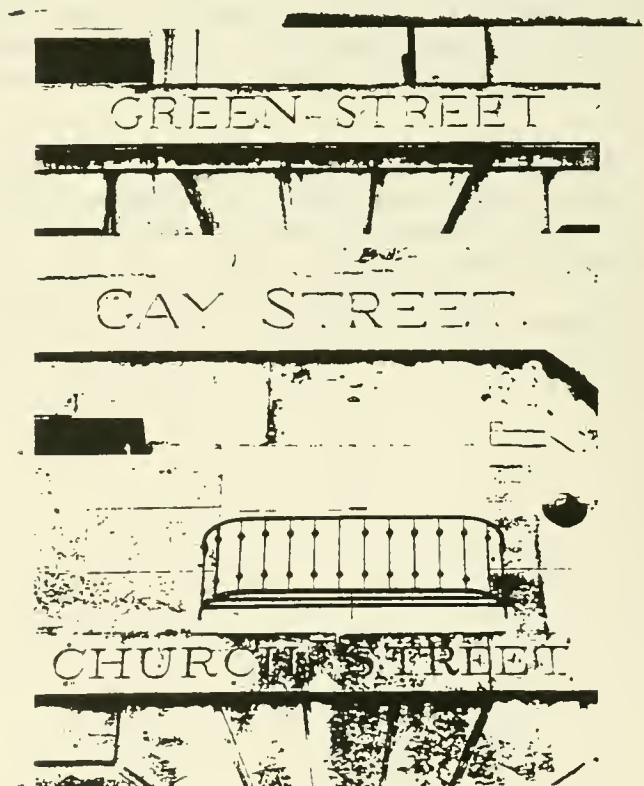
The BRA, at the request of the Freedom Trail Commission is currently involved in creating a Master Plan for the Freedom Trail which includes the development of a signage component. Currently in the schematic phase of planning, the signage will complement improvements made to the existing red line which serves as the primary identification element for people walking the trail.

The Freedom Trail is Boston's premier tourist attraction. Its sixteen sites represent the city's rich history. Located in three distinct neighborhoods the trail is the element which connects these sites. Because the trail is not self contained and can be entered or left at any point along its route, it is often confusing to follow. It is the goal of the signage program to clearly direct pedestrians along the path of the trail while allowing them the opportunity to continue to discover the many interesting elements along its route.

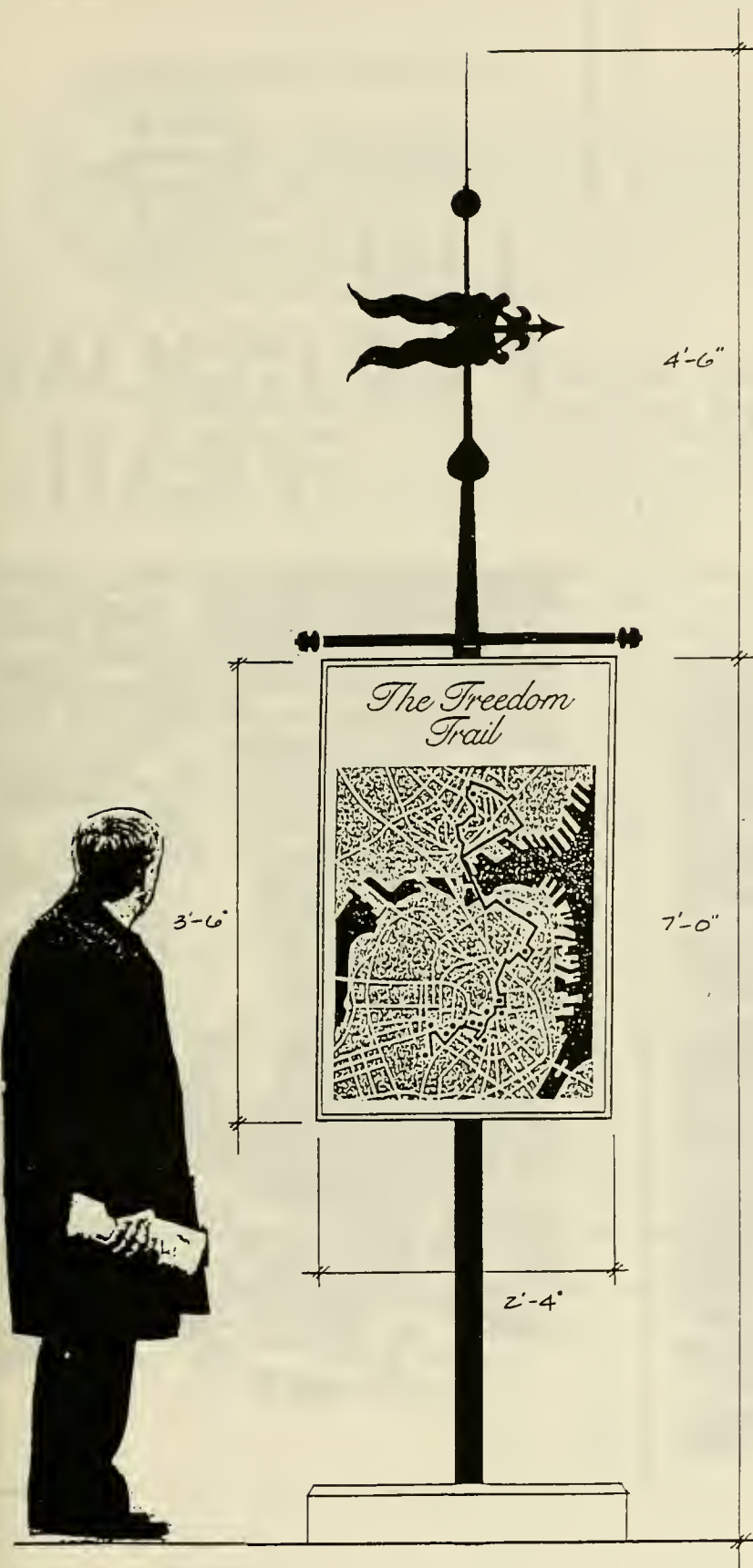
A layered system that incorporates signs, plaques, payment markings, and the read brick path is being proposed for the trail. This system will be integrated with existing graphics. It will reinforce the identity of the trail while highlighting the individual sites which are in and of themselves icons. At key decision making points kiosks will be installed. These kiosks will provide information about the trail as well as other historic sites within the immediate area.

The Freedom Trail intercepts the Double Interpretive Loop at the Charlestown Navy Yard. Here the trail parallels the loop for a short distance. As these two programs are developed, an opportunity exists to coordinate their design. This opportunity will enhance the experience of the pedestrian as they explore the city, providing increased awareness of the city's rich past.

*T*his revitalization plan is in process and being reviewed with the appropriate City agencies, Freedom Trail site directors and other members of the Freedom Trail Foundation.



Historical antecedents for signage design illustrating the importance of weathervanes and ship flags in revolutionary Boston and the use of carved granite letters for street identification.



Finial 4'0" high

Overall Height 11'6"

Base 6" x 6" x 2'6"

Sign Panels are 18 gauge steel with 1/2" returns all around, with porcelain enamel finish. Maps silkscreened in five colors.

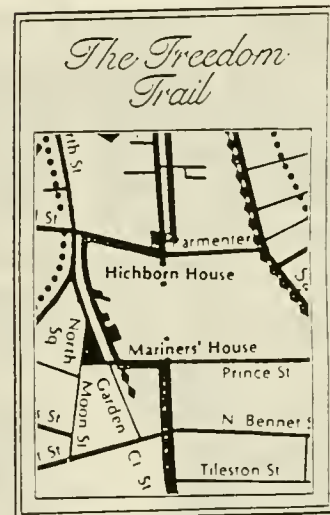
Sign post 2 1/2" dia. steel tube with welded 1" dia. steel mast arm finished with semi-gloss black or black-green catalyzed urethane enamel.

Finial is cast aluminum rod and balls with 1/8" saw cut aluminum plate weather vane finished with gloss gold metallic catalyzed urethane enamel.

Base is precast concrete or grey granite.

Freedom Trail Map - 5 colors

5 Local Area Maps - 5 colors ea.

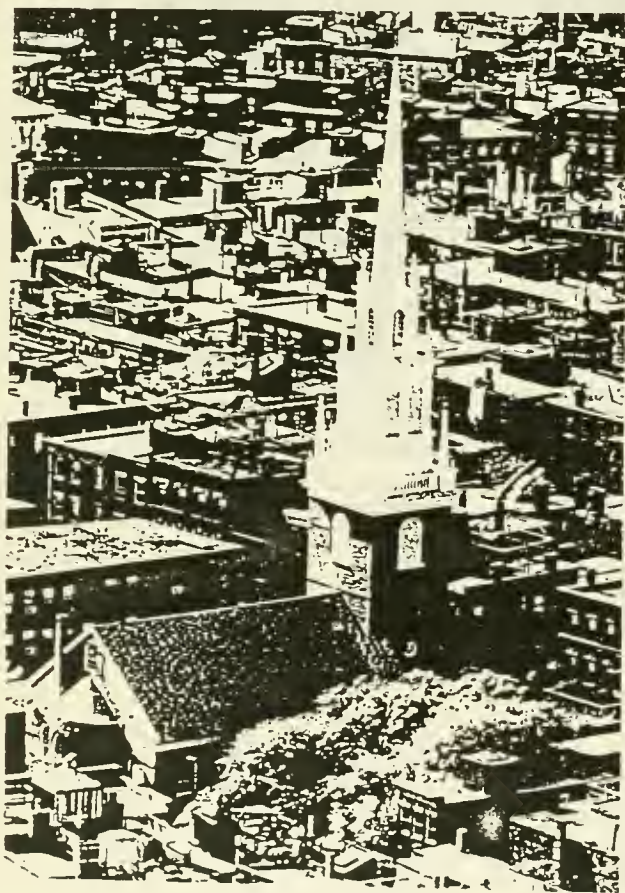


MAP KIOSK
1" = 1'-0"

The map kiosks will be placed at three to five particularly confusing and/or major locations. One side will illustrate the entire FreedomTrail; the other side will illustrate a particular neighborhood.

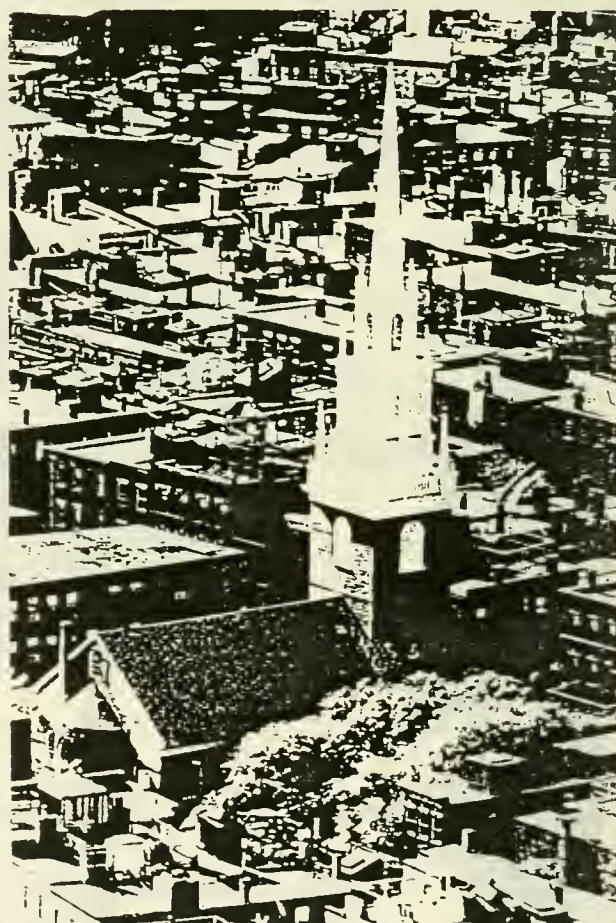
A Guide to

The Freedom Trail



A Guide to

THE FREEDOM TRAIL



Samples of new signage on printed hand-held guides.

2. Harborwalk Sign System

Harborwalk, a continuous public walkway system planned for Boston's waterfront, is an important mechanism for maximizing public access to and along the Harbor. When complete, Harborwalk will serve not only to create access to the formerly inaccessible portions of the waterfront, but also will provide opportunities for cultural, recreational and educational activities.

Harborwalk will consist of a great variety of integrated elements including: landscaped walkways with seating and lighting, parks and recreational facilities, cultural and historic facilities, fishing piers, outdoor performance areas, kiosks and shops, viewing/observation decks, marinas, sculpture and public artwork, sailing clubs, and water transportation.

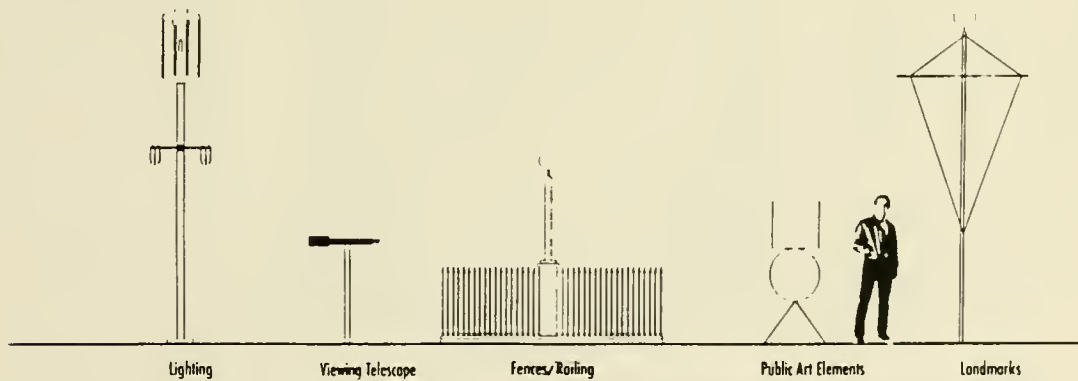
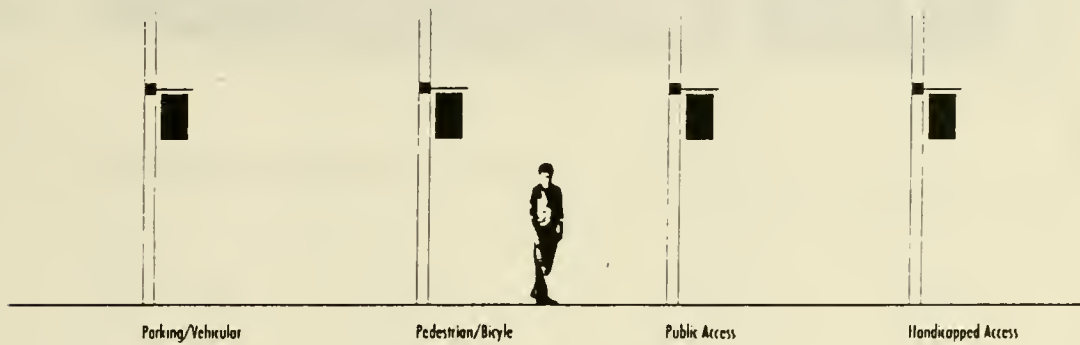
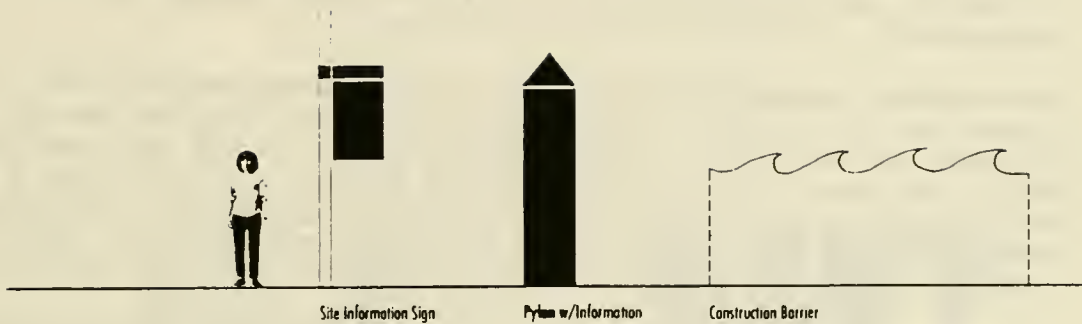
The Harborwalk Sign System, currently in design, is intended to create a distinct Harborwalk character that users can easily identify. Through linking the various publicly and privately created segments of Harborwalk to one another, it will reinforce a continuous and cohesive entity which can be experienced and enjoyed not only in parts but also as a united whole. Consisting of three dimensional graphic and other design elements the sign system will identify Harborwalk, direct people to and along Harborwalk, inform and educate people about Harborwalk, and orient people to the Harbor, to Boston and its neighborhoods.

Identification signs will identify the pathway, the prime destinations, public facilities, views and vistas, boat landings and water transportation. Direction and circulation signs will orient the public to the various elements, clarify paths, boat landings and public/private access, and link Harborwalk to the inner neighborhoods and other open spaces. Historical/cultural signs will educate the public regarding cultural activities and historic features. Social/ economic signs will promote maritime resources and industries, public and private development and recreational resources. The system will also include regulatory signs; site amenities such as lighting, viewing telescopes, and public art elements; and a logo which will serve as the primary identification and unifying element for Harborwalk.

HARBORWALK SIGN SYSTEM



Logo Concept



3. Charlestown Navy Yard Signage

In July 1989, the Boston Redevelopment Authority commenced design of the first phase of a comprehensive signage system intended to clarify pedestrian and vehicular destination points within the Charlestown Navy Yard, such as the proposed Ropewalk and Chain Forge Museums, the proposed New England Aquarium, Shipyard Park, the "Courageous" Sailing Center and water shuttle facilities. Paths of special interest, such as Flirtation Walk, Second Avenue and Harborwalk, would also be identified.

Subsequent phases were envisioned to incorporate an interpretive historic marker program and detailed retail signage guidelines. Reinforcement of existing systems of building identification (including historic street and building signs) and development of an appropriate graphic display system will remedy problems of orientation, optimize traffic circulation and create a unified sense of place.

A hierarchy of sign types for the Navy Yard was developed, incorporating recommendations for vehicular wayfinding, pedestrian wayfinding (e.g., kiosks), street name and parking signing and historic markers. Research regarding historic Navy and maritime typefaces and symbology, yielded proposals for Navy Yard logotype alternatives.



NAVY YARD

The Navy Yard Signage Plan

Charlestown, Massachusetts

Design Development Presentation

November 9, 1990

Krent/Paffett
Associates, Inc.

711 Atlantic Avenue
Boston, Massachusetts

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617 • 451 • 6301



The Navy Yard Signage Plan
Charlestown, Massachusetts

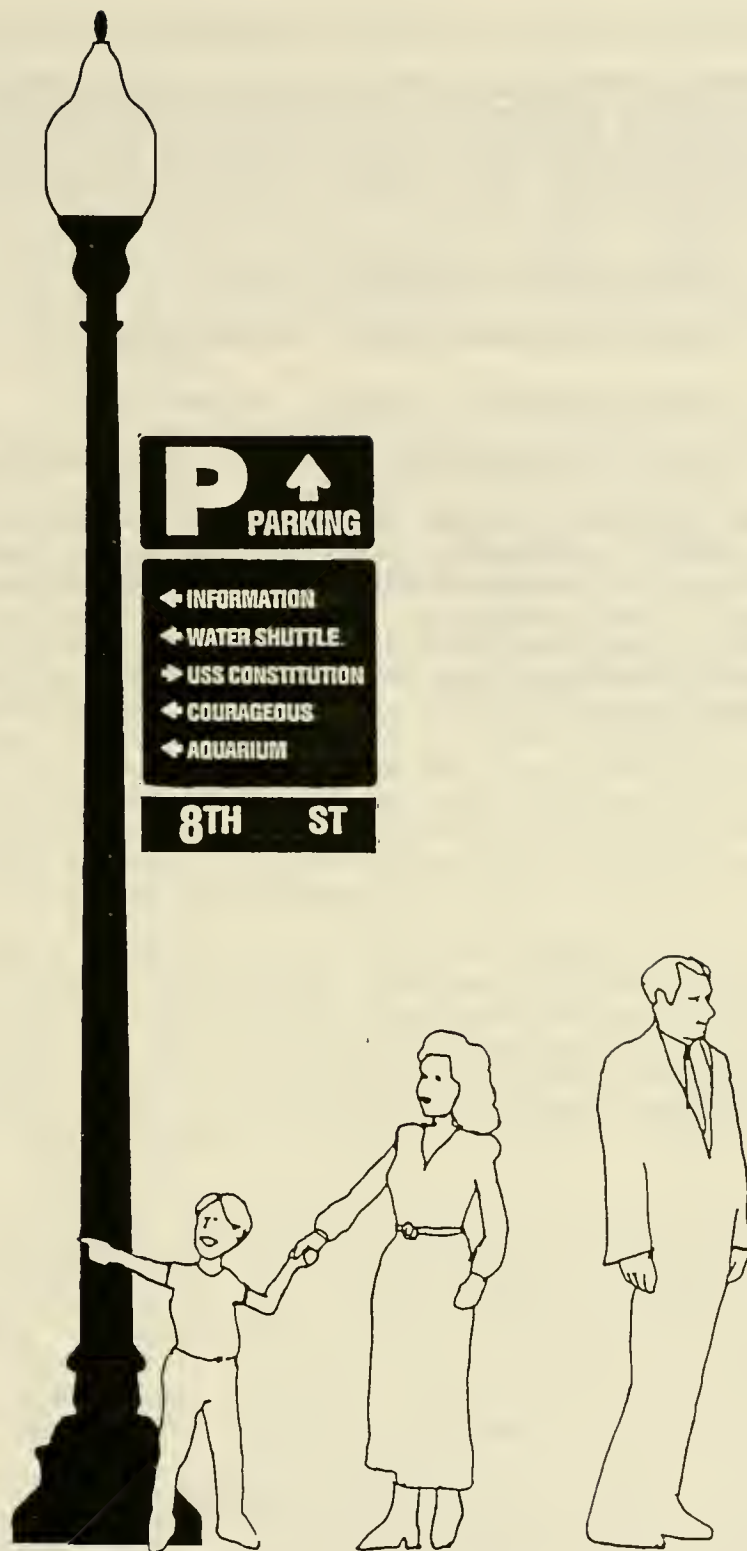
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The Navy Yard Signage Plan
Charlestown, Massachusetts

Design Development Presentation

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Associates, Inc.

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D. EXAMPLES OF OTHER INTERPRETIVE PLANS

Case-study examples of interpretive plans have been prepared as resource material for furthering discussion toward detailed designed of an appropriate interpretive concept for the Charlestown Navy Yard. The following examples are included:

1. Royal Naval Dockyard, Bermuda
2. Washington Navy Yard, Washington, D.C.
3. Mystic Seaport, Mystic, Connecticut
4. Historic Dockyard, Chatham, Great Britain

These examples are not intended to prescribe direction for developing the Double Interpretive Loop. Rather they are provided to increase understanding of what has been accomplished elsewhere. Insight may thereby be gained into what may and also what may not be appropriate for the Charlestown Navy Yard in light of their differing circumstances.

1. Royal Naval Dockyard, Bermuda

H.M. Dockyard, Bermuda served as the Royal Navy's base of operations in the western Atlantic for nearly 150 years prior to its closure in 1951. Since then, a number of Dockyards' 19th century structures built of hard Bermuda limestone have been redeveloped with uses geared towards the island's substantial tourist-oriented economy. This includes a retail arcade, restaurants, craft market and cinema. Also located within Dockyard is a cruise ship terminal, marina, boat rental, submarine tour operation and water transit facilities.

The Keep, which was the fortress built to protect Dockyard and store munitions for the fleet, is now the home of the Bermuda Maritime Museum. In addition to the exhibits housed within historic magazine buildings, the Museum has developed a Rampart Walk along the bastions of the Keep which interprets its defensive installations.

Rampart Walk is a self guided tour along a path delineated in a brochure provided at the entry of the Keep. Ten way - stations along Rampart Walk are interpreted in a relatively simple, low-key manner. No kiosks or identifying markers are provided on-site. Rather, the way-stations are identified and described solely in the brochure which also provides historical background and overview of the various artifacts, cannon, bastions and below grade magazines and casements encountered along Rampart Walk.

Gun emplacements have not been fully reconstructed to present an accurate recreation. Rather, at one of the way-stations barrels from different time periods are arrayed on the ground adjacent to the bastion structure which would have held them. This display dramatizes advances in artillery technology. The visitor is thereby engaged in imagining how these barrels would actually fit unto the emplacement.

At other way-stations below grade magazines and casements are likewise interpreted in a simple, spartan manner. The brochure alerts visitors that "the passage is dark so please walk carefully!" The simplicity and directness of exploring these dimly lit below grade structures evokes an inherent feeling of place -- the closeness and danger -- in a more dramatic way than would a highly polished exhibit design.

On the whole, Rampart Walk succeeds in conveying a lasting impression of the underlying significance of the historic artifacts encountered. An economy of means that engages all ones senses and a presentation that is relatively tightly focused on one basic aspect of the Keep -- its defensive works -- results in a clear and substantive interpretive experience.

The Rampart Walk

AT THE BERMUDESE MARITIME MUSEUM



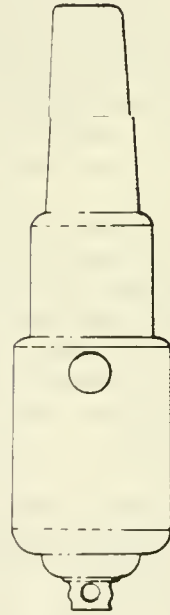
The Keep was the last line of defense in the protection of HM Dockyard, Bermuda, should an enemy successfully pass the other massive fortresses protecting its approaches by land and sea. Explore the bastions and underground magazines by following the trail inside. Start at the ramp behind the Boatlift.

BACKGROUND

The defenses of HM Dockyard, Bermuda were built and improved during the 19th century when great advances were being made in the size and range of heavy artillery.

The smooth bore cannon, developed in the 14th century, saw little improvement until the introduction of the carronade in 1779. The carronade, a mobile gun which was both short and light in comparison to its calibre, was made in larger and larger sizes, but eventually became obsolete by the 1870s.

Numerous advances were made in the mid 19th century, including the introduction of the exploding shell and the use of rifling inside the barrel, which greatly improved the range of the gun. Rifled muzzle-loaders (RMLs) and rifled breech-loaders (RBLs) were easier and quicker to load and fire, and were followed in the 1880s by quick firing breech loaders with steel barrels.



DEFENCES OF THE DOCKYARD

Period 1 (1820-1860s)

Work began in 1809, and by the 1830s, the fortifications of the Dockyard were complete. The Keep, surrounded on three sides by the sea, was armed by 1857 with 68 guns, mostly 24 and 32 pounders.

Period 2 (1870s-1905)

The Keep was re-armed in the 1870s, and concrete emplacements for 11-inch RMLs were built on five of the bastions. Two new magazines were also built, and from these shells were carried to the guns on shell-ways.

Period 3 (1900s-1920)

At the turn of the century three 4.7-inch quick-firing BL guns, for work against torpedo boats, and four 6-inch BLs were mounted on the bastions, each one supplied from an underground magazine.

Period 1 (1820-1860s): 32 pdr cannon firing a 32 pound ball over a distance of 1900 yards.

Period 2 (1870s-1905): 10 in. rifled muzzle-loader firing a 400 pound exploding shell over a distance of 4,800 yards.

Period 3 (1900s-1920): 6 inch quick-firing breech-loader (Mark VII) firing a 100 pound exploding shell over a distance of 12,000 yards.

The restoration of most of the bastions of the Keep has been supported by a number of individuals, families and companies interested in the preservation of Bermuda's maritime and military heritage.

If you are interested in supporting the Museum's Capital Campaign in this, or any other, way, please contact the Director (Tel. 234-1333).

More on Fids from the Maritime Museum Press

Bulwark of Empire

The newly-released second edition of the 1962 classic on Bermuda's defences by Colonel Roger Willock. Hardcover, 151 pages. \$25.00

Great Guns of Bermuda

For those who enjoy exploring an illustrated guide to Bermuda's fortifications, which span four centuries of military design. 40 pages. \$7.50

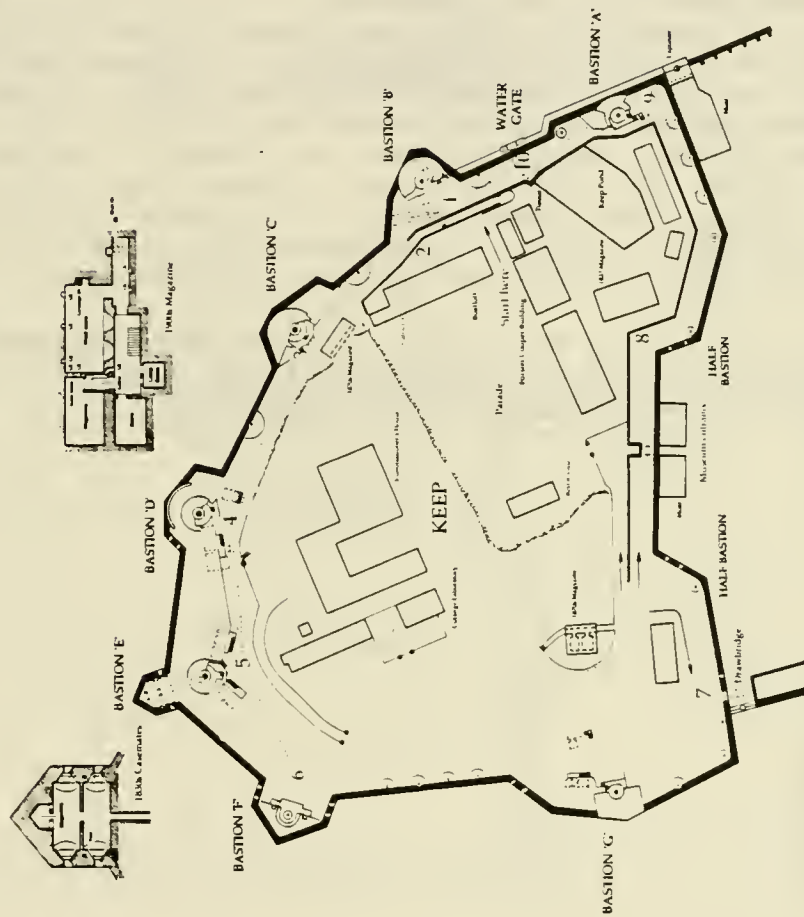
Available at the Museum Ticket Office



Bermuda Maritime Museum
P.O. Box MA 273
Mungro Bay MA BX
Bermuda

Make your next visit a free one!
Become a Member!

RAMPART WALK



Follow the numbers on the plan in the centre:

- 1 Just before going through the iron gate turn right down the tunnel and explore the 1830s casemates of Bastion B. Here, two 24-pdr carronades protected the tunnel entrance to the Keep Pond. Today, a number of 16th century guns, recovered from shipwrecks around Bermuda, are stored in the casemates
- 2 Once through the iron gate, look over the wall and you will see, half buried, the 10-inch RML gun which stood on Bastion B in the 1870s. Obsolete guns like this one, too heavy to ship back to Britain, were either pushed into the sea, or buried in the fortifications.
- 3 The two barrels lying on the ground near Bastion C illustrate the transition from iron to steel guns. The first gun, manufactured in 1862, is still shaped like the RMLs of the 1870s although with steel a fattened breech end was no longer necessary. The second, manufactured a little later, has the new streamlined shape eventually perfected in the guns of the early 1900s. A little further along the rampart wall, between the bastions, is an 1880s emplacement for a 64-pdr RML with its traversing rail still intact

4 The underground magazines at Bastion D have survived unaltered since their construction in the early 1900s. Safety was a paramount consideration in their design. Light boxes (LB) with glass shields prevented the accidental ignition of shells. Between the lobby and the magazine is a barrier where men exchanged their hob-nailed boots for non-sparking rope-soled shoes before entering the magazine.

5 To explore the 1830s casemates at Bastion E go down the stairs to the left of the bastion, and through the right-hand room at the bottom. The passage is dark so please walk carefully! Here, four 24-pdr carronades could be aligned on any person attempting to scale the ramparts. Vents above removed the smoke after firing, and spare munitions were stored in the room at the end

6 At Bastion F the concrete of the 1900 emplacement has been removed to expose the earlier gun position of the 1870s which mounted a 10-inch RML. The small recesses stored cartridges and shells brought from the magazines to the gun along concrete shell ways (now destroyed). Slots in the wall to either side date from the first period of armament in the 1830s

7 Follow the path on the map past the 1870s magazine and Bastion G (now a water catch), and around the building to the upper gate at the corner of the Keep. Here, you can see the mechanism for the narrow pedestrian drawbridge which connected the upper grounds of the Keep with the rest of the Dockyard. The drawbridge was one of a series designed by Captain T. Blanshard, Royal Engineers, who planned the fortifications of the Dockyard. It is unusual in that it retracted horizontally. Retrace your footsteps to the top of the ramp and then either make your way down to the exit or continue your walk and complete the circuit of the rampart

8 The main entrance to the Keep was protected by a drawbridge spanning the moat, and four 24-pdr carronades mounted in the two flanking half-bastions

9 At the corner of the Keep is a caponier - a covered way, protected by a ditch, which allowed the defenders to fire along the outside of the curtain wall. It was entered from the Keep by a tunnel cut through the bastion rock

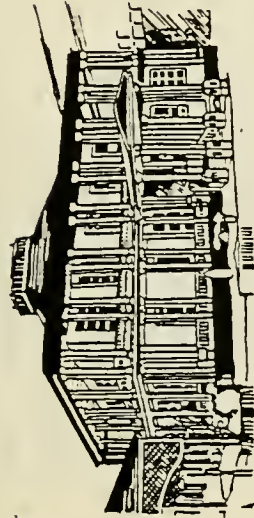
10 Turning north again, pause at Bastion A, for an unparalleled view of the interior of the Dockyard, before continuing around above the Keep Pond. The entrance to the Keep Pond was protected by a portcullis on the inside, and three 8-inch shell guns on the rampart, in addition to the two 24-pdr carronades in the casemates of Bastion B where you began your walk

Retrace your steps down the ramp and back to the Parade - we hope you have enjoyed your walk

2. Washington Navy Yard, Washington, D.C.

The Washington Navy Yard (WNY) is an active Navy facility which is partially open to the public. The WNY specialized in munitions and ordnance, and developed the first tank for wave actions studies and a very large (8 x 8 foot cross section) wind tunnel. It now houses the large Navy Museum and Annex (Submarine Museum), the Marine Corps Historical Center and Museum, a Navy-related Art Gallery, a naval vessel (former U.S.N. Destroyer Barry) open for visits, and Willard park (and amphitheater) with numerous artifacts associated with the Washington Navy Yard. The facilities listed above, the Navy Yard Chapel, the Public Affairs office located in the Commandant's House, Leutze Park, and the Dudley Knox History Center are open to the public. Interpretive elements around the Yard consist of enamelled, post-mounted metal plaques which explain an artifact or describe the historic significance of a particular building or area. Some areas remain off-limits to visitors; other areas and buildings (such as the Latrobe Gate and Optical Tower) may be visited only on a guided tour.

The Washington Navy Yard is a National Landmark; Tourism is promoted and facilities maintained by the U.S. Navy. Educational programs are highlighted.



Building One

1 The Navy Museum Bldg #76

The Navy Museum, which opened in 1963, is housed in the former 600-foot long, Breach Mechanism Ship of the old Naval Gun Factory. Exhibits offer a look at the traditions and contributions of the Navy throughout American history. Popular attractions include the fully rigged fighting top from the Frigate Constitution, a submarine room with operating periscopes, and a variety of large guns which can be elevated and aimed by the visitors.

2 Chapel Bldg #106

This building was originally constructed as the pneumatic power plant for the large ship in 1901. Volunteers, provided by the Navy's Self Help Program, converted the power plant into a chapel. In 1973 the Navy Yard Chapel was completed without destroying the building's industrial character.

3 Willard Park

This park is named for Rear Admiral Arthur Lee Willard, who was Commandant of the Yard from 1917-1919 and again from 1927 to 1930. The weapons and naval hardware found in the park make up the outdoor extension of The Navy Museum.

4. Barry (DD-933) Pier #2

The former United States Navy Destroyer Barry (DD-933), is permanently moored at Pier #2 as a permanent display ship in the nation's capital. She was commissioned on 7 December 1956 and served 26 years in the Atlantic and Pacific Fleets.

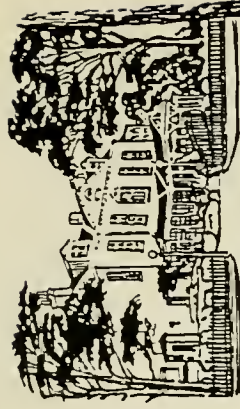
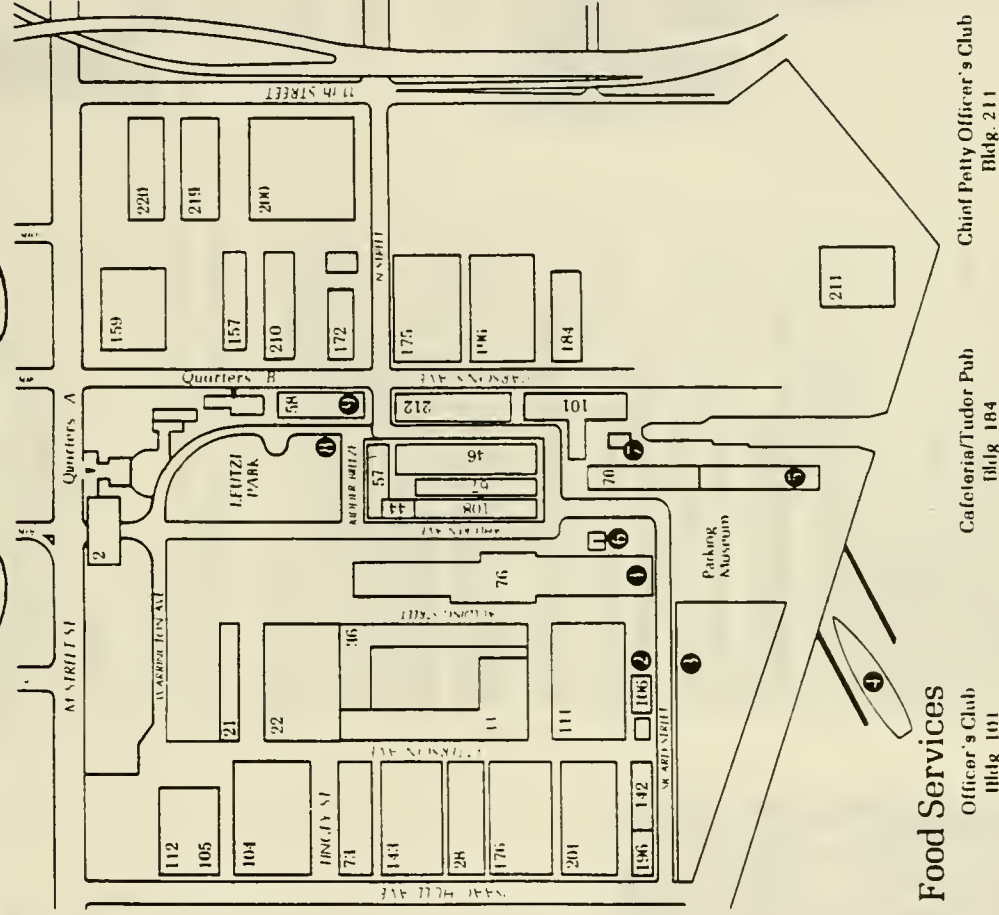
5 Experimental Model Basin

Bldg #70

In 1897-1898 the model basin was designed and built under the supervision of Naval Constructor David Watson Taylor. Scale ship models were towed the length of the 470-foot basin while scientific and photographic equipment measured the effect of water on

Washington Navy Yard

Historic Landmark



Quarters "A"

the hull. The south end of the building now houses the Submarine Museum. Among the displays are a variety of early submarines including the 1860's Intelligent Whale and three World War II Axis mini sub-A Poseidon missile, specifically designed in the 1970s to be launched from submarines, is also displayed.

6 Commandant's Office Bldg #1

This two-story building was constructed in 1837-1838 to provide offices for the Commandant of the Yard. Originally, it was completely surrounded by porches on both stories. The present appearance dates from 1948 when most of the porch was enclosed with weatherboarding.

7 Marine Railway South of Bldg #101

In 1822 Commodore John Rodgers designed and built the first marine railway in the United States. The railway hauled ships out of the water for repair or hull preservation. In 1823 a permanent railway and large covered shiphouse were built.

8 Leutze Park

This park is named for Rear Admiral Eugene H. C. Leutze, who was Commandant of the Yard from 1905 to 1910. The park is used as a parade ground for formal affairs as the "Ceremonial Quarterdeck of the Navy." Surrounding the park is a collection of historical bronze ordnance captured as trophies of combat by U.S. forces.

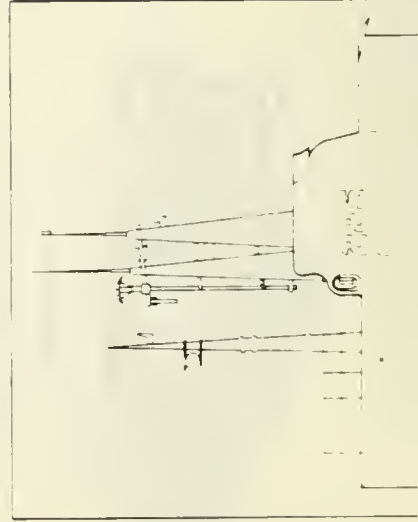
9 Marine Corps Historical Center Bldg #58

This three-story, brick structure was built in the mid-19th century on the side of the old stores building. The Marine Corps Historical Center maintains the archival, research, library, and museum facilities of the United States Marine Corps. The Marine Corps Museum on the first floor presents the history of the Corps through its collection of historical objects and works of art.

Fairweather from Balao (SS-285)

Balao, first of a class of 195 submarines, was built in 1942 at Portsmouth Navy Yard, New Hampshire. During World War II Balao served in the Pacific. Balao went into the naval reserve in 1946. Six years later she was recommissioned. In 1959 she co-starred with Cary Grant as the "pink submarine" in the film *Operation Petticoat*. Balao was decommissioned on 1 August 1963.

The fairweather has its original periscopes and radar antennae which are still visible. After World War II the Navy altered the fairweathers of the Balao class by adding a snorkel, removing deck guns, and streamlining the front for higher underwater speeds.



The Navy Museum Annex

is part of

The Navy Museum
Washington Navy Yard
9th and M Streets SE
Washington, D.C.
20374-0571

Telephone: (202) 433-4882

MUSEUM HOURS

Monday through Friday:
9:00 a.m. to 4:00 p.m.

Weekends and Holidays:
10:00 a.m. to 5:00 p.m.

PUBLIC TRANSPORTATION

SUBWAY: The closest Metrorail stop is at Eastern Market at 8th Street and Pennsylvania Avenue SE on the Blue-Orange Lines. Walk (15 minutes) down 8th Street to M Street. Turn left. Walk one block to 9th Street and turn right into the Navy Yard.

BUS: Metrobus numbers 54, 52, V4, V6, 92 and 94 stop in front of the Navy Yard.

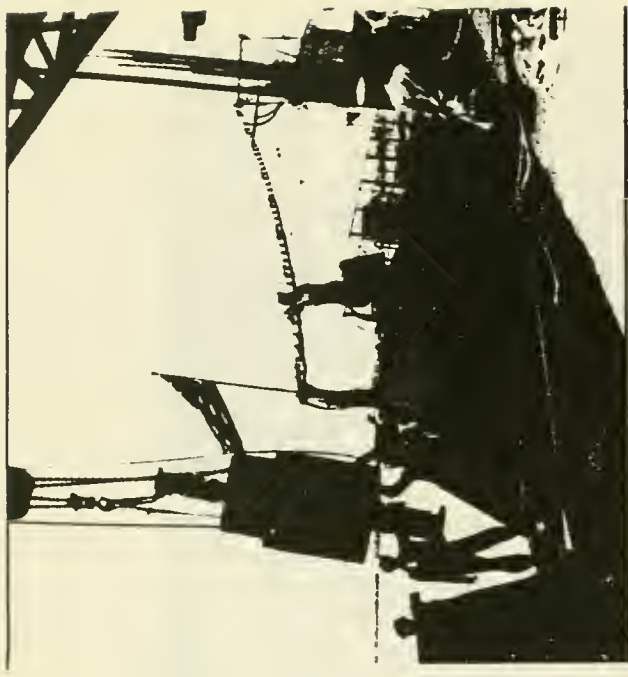
FOOD

A variety of food service is available in the Navy Yard. Reservations are necessary at the following places:

Officers' Club: 433-3041

Chief Petty Officers' Club: 433-2523
Picnic tables are located in the park outside the Museum.

• U.S. GOVERNMENT PRINTING OFFICE 1989-0-620-526



*Please pardon
our appearance
while we are
undergoing
renovation.*

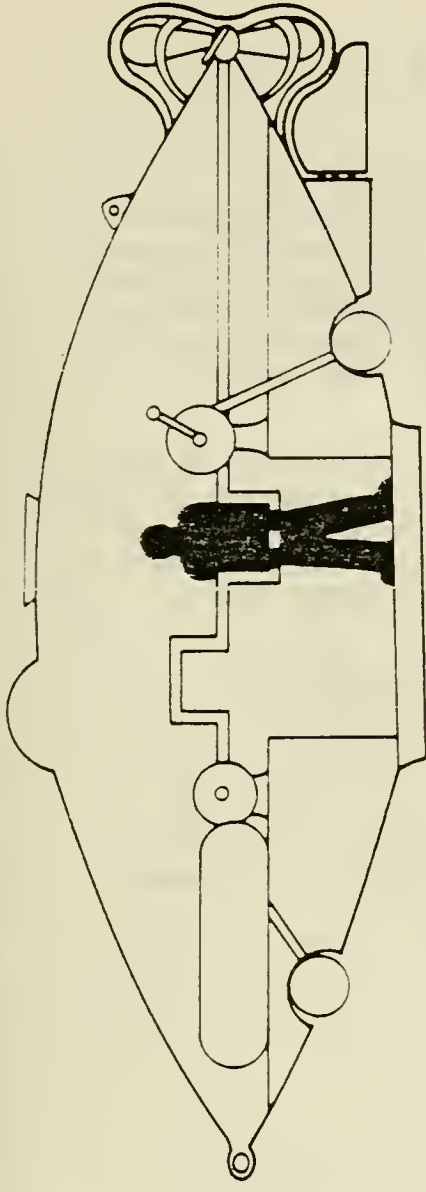
The Navy Museum Annex

The building housing our collection of rare and unusual submarines and related artifacts is slated for major renovation within the next few years. Due to the interest in the collection, we are keeping the building open to the public.

Pressure Hull with Conning Tower of *Roncador* (SS-301)

The pressure hull has been removed from *Roncador*, a *Balao* class submarine. The Museum is carrying out a program of restoration and renovation of the conning tower within before opening it to the public.

The conning tower served as the main navigation and fire control station in a submarine. A number of important systems aided the crew with performing these functions. The equipment in the conning tower included the main steering stand, Torpedo Data Computer, Torpedo Firing Control, sonar, radar, and periscopes.



Intelligent Whale

Intelligent Whale was one of a number of submarines built during the Civil War. She was hand propelled by a crew of six to thirteen. *Whale* was steered by horizontal and vertical rudders. The boat could stay submerged for up to ten hours. Wooden gates on the bottom allowed a diver to exit with a mine. He would attach it to the target, then return to *Whale* from where the mine could be detonated.

In the late 1860s General Thomas W. Sweeney made a successful test of the submarine. Sweeney

recommended the vessel to the Secretary of the Navy. Consequently, in October 1869 the Navy Department agreed to purchase the boat. The owner, Oliver S. Halstead, brought it to the Brooklyn Navy Yard where it was named *Intelligent Whale*. In summer 1872 the Navy Department appointed a commission to observe and report on *Whale*'s test. In September in its only official Navy test, *Intelligent Whale* flooded and, even though the crew escaped, the Navy's interest ceased. The boat remained in Brooklyn Navy Yard until the mid-1960s.

3. Mystic Seaport, Mystic, Connecticut

Mystic Seaport is a set piece, an agglomeration of stylistically and thematically related structures imported from various sites and arranged to accentuate the experience of the visitor. The original industry and buildings on the site were in fact shipbuilding-related. Secondary commerce related to shipbuilding, provisions and maintenance, and whaling related services are represented in the added buildings.

Stylistic considerations have governed the evolution of the interpretive and wayfinding signage and are suggested in the self-guiding map illustrated. Artifacts, interpretive and interactive exhibits, and a small village quality with small scale signposts pointing to destinations complete the picture.

Mystic Seaport also markets itself as a destination aggressively. Brochures are found at every tourist information center, and the Mystic Marinelife Aquarium and Mystic Village (a theme mall) have been developed as aggregate attractions. Visit Planner brochures, listing over a dozen annual special events, as well as areas of interest for further information (camps, cruises, classes, etc.), are distributed.

SUMMER EVENTS

No.7 June 24 to September 2, 1991
Open 9 a.m. to 8 p.m.

SAIL HANDLING

Charles W. Morgan 9:45, 3:30
Joseph Conrad 11:00, 1:45

MEET A ROLEPLAYER FROM 1876

Sailors' Reading Room (12) or on the grounds 10:30 to 4:00

DEAD HORSE CEREMONY

Joseph Conrad 10:45

WHALES AND TALES: TOURS FOR KIDS

Tickets available at the Visitor Reception Center
11:00, 1:00, 2:00

WHALEBOAT DEMONSTRATION

Middle Wharf 11:30

"WHALES, WHALING, AND WHALEMEN"

A thirty-minute program on 19th-century whaling
Meeting House (43) 11:30, 12:30, 2:30, 3:30

GALLERY TALK "Neptune's Attic..."

Sixty Years of Collecting at Mystic Seaport Museum"
Schaefer Building (42) 11:30, 2:15

"THE SUMMER STARS, GUIDING LIGHTS OF THE MARINER"

Minimum age admitted 5 years. Admission is charged.
Visitors are admitted only during the 15 minutes prior to
the start of the thirty-minute program.
Planetarium (39) Hourly 12:00 through 5:00

"A TALE OF A WHALER"

A Participatory Play
Chubb's Wharf
[If rain, Red Barn (13)] 12:15, 1:30, 3:00, 4:30

NINETEENTH-CENTURY GARDENS

Buckingham House Garden (37) 12:15, 3:30

CAPSTAN DEMONSTRATION

Joseph Conrad 1:15

"MUSIC OF THE SEA AND SHORE"

Village Green [If rain, Tavern (18)] 1:45

FISHERIES AND DORY HANDLING

L.A. Dunton 2:15

OYSTERING DEMONSTRATION

Next to Thomas Oyster House (3) 2:30

TOY BOATS AND GAMES ON THE VILLAGE GREEN

2:30 to 8:00

ROPEMAKING

Clam Shack (35) 4:30

POWER FOR A NEW CENTURY

Hoop Shop (26) 4:45

BREECHES BUOY RESCUE

Village Green 5:00

RIVERLIFE ACTIVITIES

Middle Wharf 5:00 to 8:00

AN EVENING OF MUSIC

Village Green (If rain, Galley) 5:15 to 8:00

Monday Yankee Notions-Traditional Songs
of New England

Tuesday The Silver Cornet Band

Wednesday Forebitter-Sea Music

Thursday Centerbrook Brass

Friday Feature Concert Night

Saturday Wickford Express-Sea Music

Sunday The Little City String Band

LOBSTERS AND LOBSTERMEN

Lobster Shack (6) 5:30

FISH SPLIT

L.A. Dunton 5:30

FISH SMOKING

Smoke House (14) 6:00

SPECIAL ENTERTAINMENT

See sign-boards around the grounds
for location 6:00 and 7:00

Monday Josiah Gardner, Sea Tales

Tuesday Punch and Judy
19th-century Puppet Show

Wednesday The Magic of the Sea
Magic Lantern Show

Thursday Mr. E.A. Davis-Magician

Friday Stories of Maritime New England

Saturday Medicine Show

Sunday Fuu-Fuu Band
Sailors' Music with Wickford Express

CASK RAISING

Chubb's Wharf [If rain, Cooperage (21)] 6:15

ROPEMAKING AND MARLINSPIKE

SEAMANSHIP
Clam Shack (35) [If rain, Ropewalk (33)] 6:45

SCRIMSHAW: THE FOLK ART OF THE WHALEMAN

Whaleboat Exhibit (36) 7:15

FAMILY SKY WATCHER'S GUIDE

Planetarium (39) Wednesday evenings 8:30
An informal program of star, planer, and constellation
identification in the Planetarium, followed (weather
permitting) by outdoor viewing with our telescopes.
\$2 per person

4. Historic Dockyard, Chatham, Great Britain

The Royal Dockyard was established at Chatham some four centuries ago during the reign of Henry VIII and remained in operation until 1984 when it was closed and earmarked for redevelopment. Eighty acres that make up the oldest portion of the yard were given to a specially created Chatham Historic Dockyard Trust which has managed its re-use as an historical museum/interpretive precinct. A general admission charge provides access to four main galleries housed in historic structures including the Ropery, a late 18th century ropemaking complex still engaged in the active production of rope.

The Historic Dockyard is very much a working museum with opportunities to see traditional skills and crafts in action. The historic buildings and drydocks date from the 18th and 19th century and include the Commissioner's House built in 1704 which is the oldest naval building to survive intact in Great Britain.

Guided tours lasting approximately 1/2 hours are provided. In addition a self-guided "visitor route" is delineated in a brochure. Special guidebooks are available for purchase. These guidebooks provide more detailed information and perspective about the Dockyard. For example the Ropery Visitor Handbook includes description of the Ropery buildings; the raw materials of ropemaking; the processes of ropemaking; and the ropemakers.

Visitors to the Ropery can see demonstrations of ropemaking and also exhibitions about the history of the Chatham ropery which at the height of its production employed over 300 people around the turn of the 19th century. Today, the Ropery employs 12 people working for a company which is owned by the Chatham Historic District Trust.

Welcome to The Historic Dockyard

There was a Royal Dockyard at Chatham for four centuries, from the reign of Henry VIII to the reign of Elizabeth II. In the care of the Chatham Historic Dockyard Trust since 1984, this 80-acre site with its 47 Scheduled Ancient Monuments forms the most complete Georgian and early Victorian dockyard in the world.

Within this unique collection of buildings, the story is told of the building of Britain's fighting ships and the lives of the dockyard craftsmen.

Take a guided tour or explore by yourself this living, working museum—it's alive with surprises!

SMOKING: Visitors are requested not to smoke in the Dockyard buildings

HALF-PRICE RETURN VISIT

Because there is so much to see, we invite you to make a return visit at half the applicable normal admission price on production of this ticket.

This offer closes 28th March 1992.

The Buildings

- 1 Calvanising Shop
- 2 Wheelwrights' Shop
- 3 Mast Houses and Mould Loft
- 4 The Covered Slips
- 5 Dry Docks 3 and 4
- 6 Dock Pumping Station
- 7 Clocktower Building
- 8 Dry Dock 2
- 9 Admiral's Offices
- 10 Commissioner's House
- 11 Assistant Queen's Harbourmaster's Office
- 12 Anchor Wharf Storehouses
- 13 Ropery
- 14 Hemp Houses
- 15 Yarn Houses
- 16 Lead and Paint Mill
- 17 Main Gate
- 18 Guard House
- 19 Dockyard Church
- 20 Sail and Colour Loft
- 21 Captain of the Dockyard's House
- 22 Cashier's Office
- 23 Officers' Terrace
- 24 Joiners' Shop
- 25 House Carpenters' Shop
- 26 No. 4 Smithery
- 27 Timber Seasoning Sheds
- 28 Saw Mill
- 29 Site of South Mast Pond
- 30 North Mast Pond
- 31 Lower Boat House
- 34 The Billiard Room
- 35 Stables

The Galleries and Attractions

- 1 Visitor Centre
- 2 Wheelwrights' Restaurant
- 3 Wooden Walls Gallery
- 4 Historic Craft, Steam Centre
- 5 The Cannon, exhibition and ship
- 6 Medway Heritage Foundry
- 10 Commissioner's Garden and Shop (access via building 22)
- 13 Ropery Gallery
- 16 Historical Society Museum
- 20 Sail and Colour Loft
- 24 Ordnance Gallery
- 25 Craft Workshops
- 26 No 1 Smithery Viewing Gallery
- 32 Thunderbolt Pier
- 33 Hovercraft Gallery
- 34 Temporary Exhibition Gallery and Bookshop
- 35 Stables and working horses

TOILETS WITH WHEELCHAIR ACCESS

INFORMATION

RESTAURANT

PICNIC AREA

MOTHER & BABY ROOM

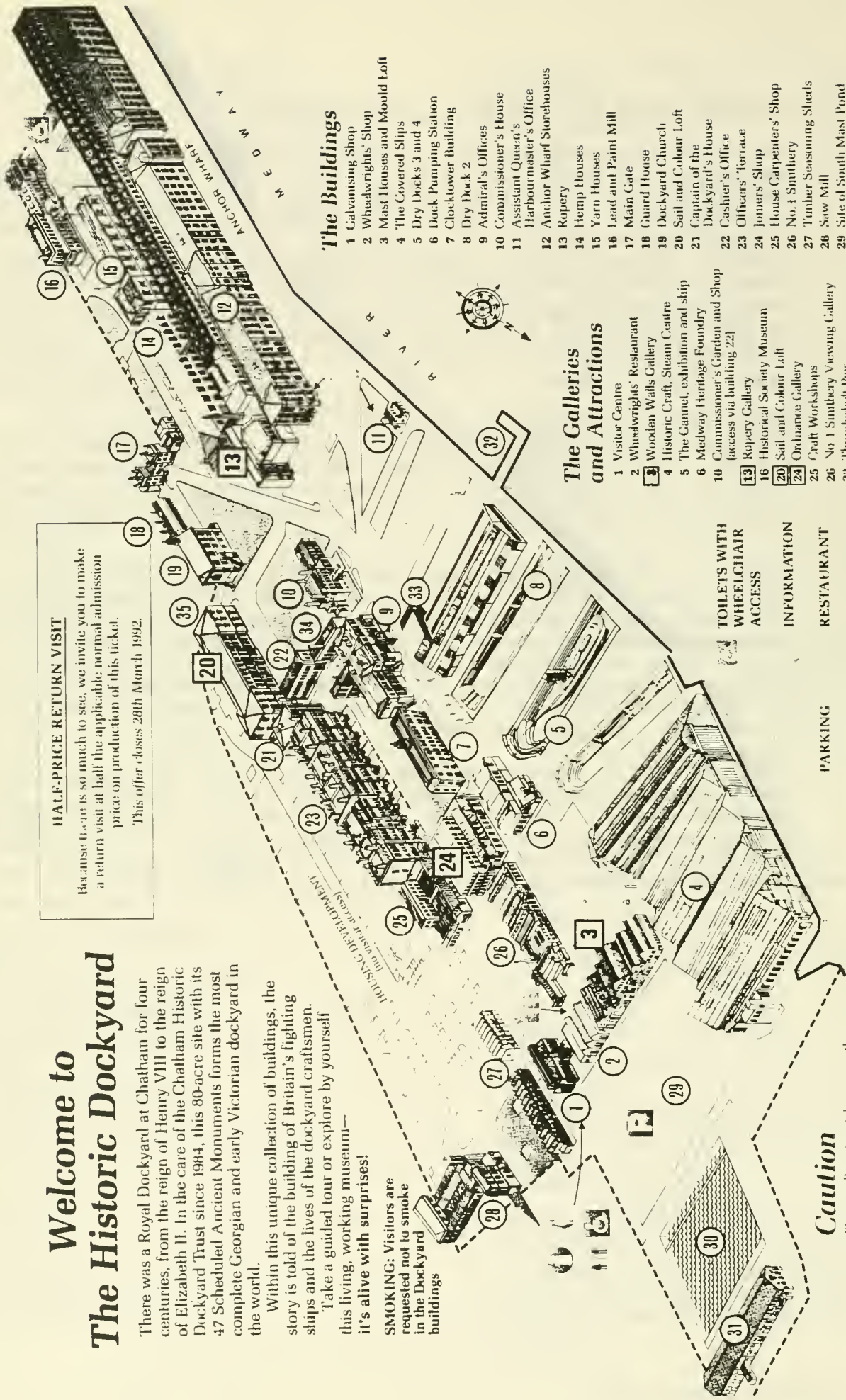
PARKING

TELEPHONE

TOILETS

Caution

Please visit visitors take care as they walk round the dockyard. Those with children are especially asked to keep them away from the dry docks, cranes, ladders and red-painted electrical boxes on many buildings



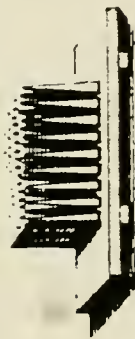
THE PROCESSES

EARLY METHODS

HATCHELLING

In ropemaking the first task is to prepare the raw material for spinning. This process, known as 'hatchelling', involves combing out the fibres to untangle them. Today this is carried out by machines in the Spinning Room, but before 1861 it was done by hand in the Hatchelling House.

The bales of hemp were opened by skilled ropemakers, known as 'parters'. They removed any bad



A hatchel, late eighteenth century

material and sorted the hemp into bundles weighing around 67 lb (30 kg) which were taken to labourers in the Hatchelling House. These men passed the fibres through a hatchel. This was a wooden board with forty iron spikes, each a foot (300 mm) long, arranged in rows. It acted like a giant comb, cleaning and straightening the fibres. A pint of whale oil (known as 'tram' oil) was poured onto each bundle to make the fibres supple and easier to pull through the hatchel board. Up to 2 lb (900 g) of fibre was lost in this process.

Hatchellers in Frost Brothers' ropery, c. 1906



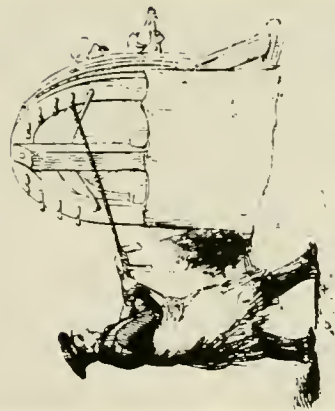
The bundle of straightened fibres was sent to the spinners to be turned into yarn. Since 1861 this process has been carried out by machines located in the Spinning Room above the Hemp Houses.

SPINNING YARN

After hatchelling, the fibres are spun into yarn. Before mechanisation (1861), this was done by hand on the upper floors of the Ropehouse.

The Ropehouse had five pairs of spinning frames, three on the first floor and two on the second. Each pair of frames was operated by a team of sixteen spinners and two labourers, with one frame at either end of the floor. Every frame had eight bunks – one for each spinner. The bunks were spun by a labourer turning a large wheel.

A spinner would wrap a bundle of fibre around his waist and twist some of the fibres onto his bunk. As the

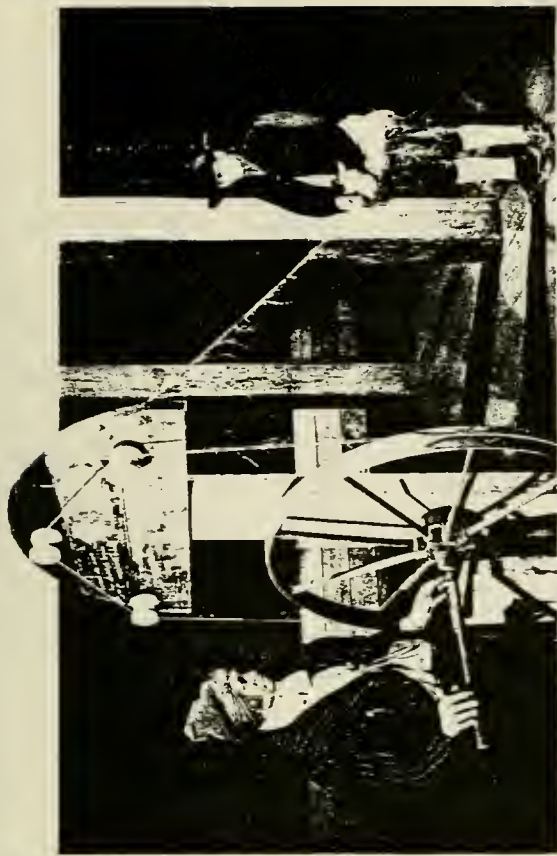


Spinner with a bundle of hemp round his waist, c. 1830

bunks were turned, he walked backwards away from the frame, keeping the fibres taut. The turning of the hook twisted the fibres together to form a yarn. With one hand he fed new fibres into the yarn from the bundle around his waist. His other hand was used to keep the newly spun yarn round and smooth. This was a very skilled job. If the rope was to be strong, the thickness of the yarn had to be kept constant through out its length.

Each spinner walked the full length of the building, producing a yarn 1,020 ft (311 m) long. The yarn was taken off the hook and the spinner was ready to begin again. This time he used his team's other frame, avoiding an unproductive walk down the floor. A spinner was expected to produce eighteen yards from a 65 lb (29 kg) bundle of fibre. This was a normal day's work.

The completed yarns were taken to the White Yarn House, where they were stored to await tarring.

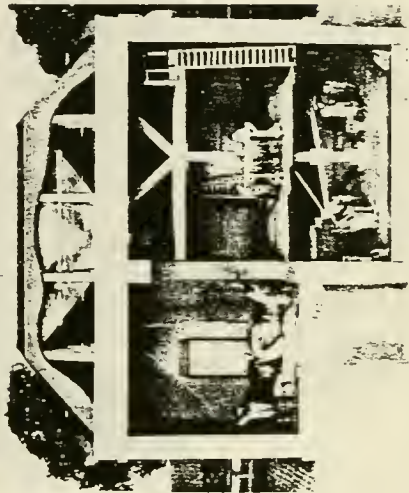


Model of a spinner, with a labourer turning the wheel

TARRING

In the eighteenth century, hemp yarn was dipped in boiling tar to protect it from decay. From the White Yarn House, the yarns were drawn by capstans through a tar kettle in the Tarring House and into the Black Yarn House, where they were allowed to dry. Before the 1780s the capstan was worked by teams of men, naked because of the great heat. They were replaced by horses working in the cellar beneath the Tarring House. Tarring was used until the early twentieth century, when hemp was replaced by manila.

Model of the Tarring House, showing the horses working below ground level



MECHANICAL SPINNING

Mechanical spinning was first introduced to the Ropery in 1861. Machines were installed on the first floor of the Hemp Houses to carry out the tasks of both the hatchellers and the spinners. They were developed from those used in the textile industry in the North of England. A steam engine was fitted in a newly built engine house (now the Test House). Power was

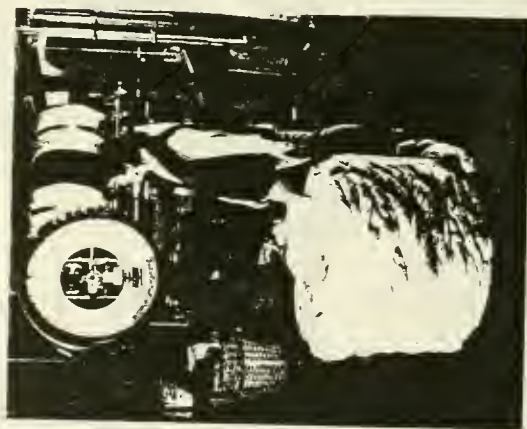


Women workers in the Spinning Room, c. 1902

transmitted to the machines by overhead line-shafting and drive belts. Some of the shafting can still be seen in the Spinning Room. The machines are now powered by electricity.



Fibre passing through the scutcher



Weighing the fibre

Following the example of the northern cotton and woolen mills, the Ropery brought in women workers to operate the new machines. Employed as machine minders, the women were paid much less than the skilled spinners they replaced. The sexes were kept well apart, with the women having separate entrances, staircases and mess rooms.

For many years women's jobs in the yard were reserved for the widows of dockyardmen, sailors and dockyard police. Single women were only recruited as a last resort. It is said that the female employees of the Spinning Room were always referred to as 'the women of the ropery', whilst those employed making flags were known as the 'ladies of the colour loft'.

THE SPINNING ROOM TODAY

There have been several changes of machinery since 1861. Some early twentieth-century hemp machines survive, although no longer in use. They can be found at the northern end of the Spinning Room, to the right of the visitor entrance. They have been replaced by new machines, better suited to the manila and sisal fibres. These were installed in batches from the 1910s onwards. Most of the machines were made in the late 1970s. All remain in use today.

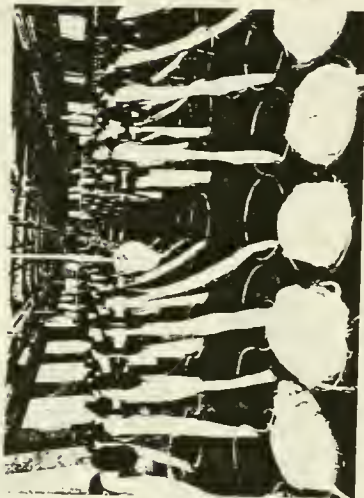
THE PROCESS TODAY

Bales of manila or sisal are hoisted up to the Spinning Room from the Hemp House below. They are opened and sorted, and the fibre is cut to lengths of about 3 ft (900 mm) by two circular cutters [1]. The hanks of fibre are placed on the tables of the spreader [2]. This is the first of a series of machines which perform the hatching (machine hatching) process. It begins the combing out and cleaning of the fibres by pulling them across rows of pins. At the same time the fibres are treated with a liquid batching compound, the modern equivalent of whale oil. This lubricates them and helps prevent rot. It is held in tanks above the machine and sprayed onto the fibres as they pass beneath.

The fibres are then passed through two scutchers [3] which both perform the same task. These comb the fibres further by passing them through more pins

More batching compound is sprayed on, and the scutchers also bring the fibres together to form a continuous sliver of raw material.

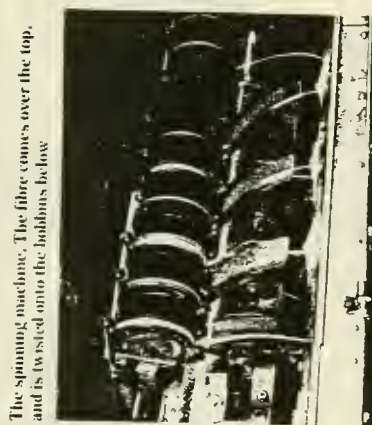
After hatching, the sliver of fibre is taken to the hell frame or drawing frame [4]. This refines the sliver further, so that it becomes more consistent in thickness and weight. After 990 ft (302 m) of sliver has passed through, it is pulled off and weighed on nearby scales [5]. Four lengths (hundreds) are selected so that they add up to a total weight of 530 lb (240 kg).



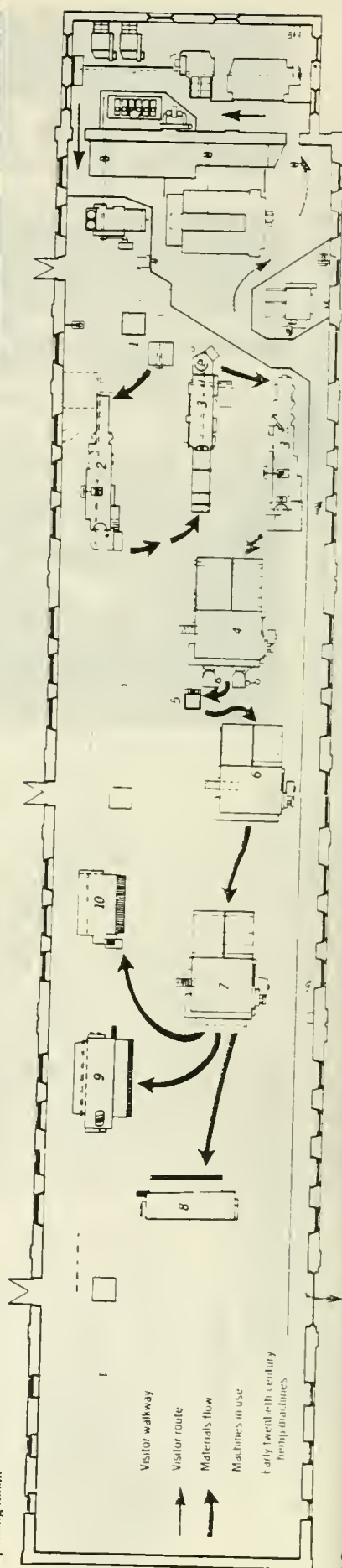
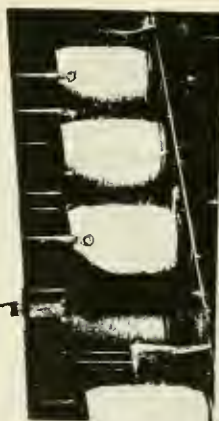
The 'twelve can' machine

This 'balanced' group of bundles is then taken through the second drawing frame, known as the 'four can' machine [6], where the four slivers are combined to form a single sliver of fibre which is fed into a container or can. The process is repeated on a third drawing frame, the 'twelve can' machine [7], further combining and combining the sliver. The fibre is now ready for spinning.

There are three spinning machines [8, 9, 10]. Each can spin up to twenty-four yarns at once, but one [10] is used for thinner yarns. The sliver is fed over the top of the machine through guides and rollers to a 'lier',



The spinning machine. The fibre comes over the top, and is twisted onto the bobbins below



Spinning Room

FORMING STRANDS

The final stages of ropemaking take place on the Ropewalk, the ground floor of the Double Ropehouse. The two processes which are carried out here are known as 'forming' and 'closing'. Both use methods developed between 1790 and 1815, and machines which date from the same period.

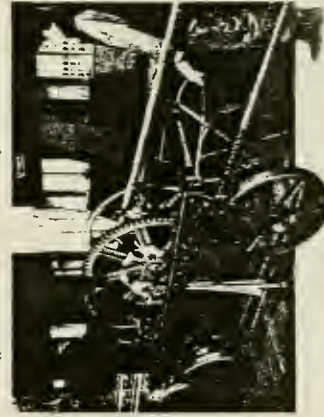
The bobbins of yarn are mounted on racks at the south end of the Ropewalk. A number of yarns will be twisted together to make a strand. The number varies with the size of rope: for example a three-inch-circumference (76 mm) rope is made up of three strands, each of twenty-four yarns.

Originally a strand was made by simply laying a number of yarns along the floor and then twisting them together. The yarns on the outside of the strand would bear more stress than the others, and would break first. In the 1790s Joseph Huddart invented the register plate and forming tube. The register plate is a metal disc perforated with holes, like a colander. Each yarn is taken through a separate hole. 'Reeving' the register plate is one of the most skilled jobs in ropemaking, for in threading the plate, the ropemaker controls the cross-section of the strand. Too many yarns on the outside and too few on the inside will produce friction between the threads. Too few on the outside and the strand will be liable to rot.

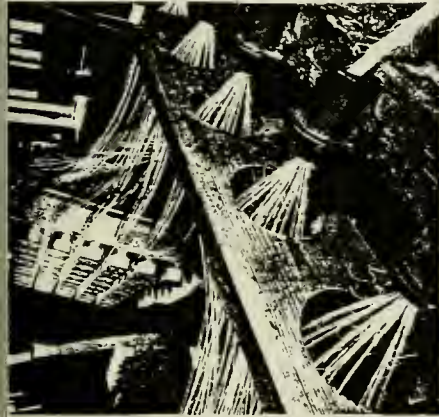
After the register plate, the yarns are then led through the forming tube or 'die', a metal tube which compresses them into close contact with one another. These devices, still in use today, make sure that all the yarns are equally taut, and bear an equal share of the stress. Their introduction doubled the strength of rope.

The yarn ends are then attached to a hook on a forming machine. This is mounted on wheels and is pulled down the whole length of the floor, drawing the yarns off the bobbins and through the register plate and tube. At the same time, the hook is turned to twist the yarns into a strand. There are several

The reel banks, register plate and forming tubes, from a drawing of 1800

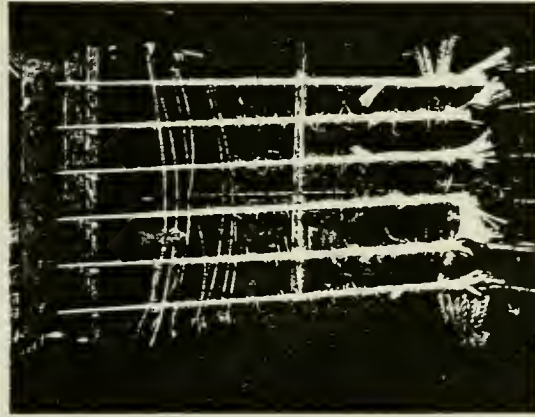


Forming strands with the Maudslay machine of 1811



Yarns going through the register plates and forming tubes, with the bobbin banks in the background

The yarns are led from the tubes to the hooks on the forming machine, and are twisted to form strands



forming machines, used for different sizes of strands. Each machine can make up to six strands at a time, and is driven by ropes taken round a capstan at the north end of the building.

The forming machines in use today were developed after a visit by Simon Goodrich, the Admiralty's engineer, in 1808. The Ropey at Chatham contains the earliest-known example of this type of machine. It was made in 1811 by Henry Maudslay, one of the greatest engineers of the age.

When the forming machine has travelled the length of the Ropewalk floor, strands of 275 metres have been made. The strands are cut off at the forming tubes and at the hooks of the forming machine. They are left to settle, stretched between two upright posts. After a suitable period the strands are ready to be closed into rope.

In the eighteenth century, an untarred yarn was placed in the centre of each strand of tarred rope made for the Royal Navy. This was known as 'rogues' yarn' and would identify the rope as government property if it was lost or stolen. Later, coloured yarns were used for this purpose. Rope made at Chatham has a yellow yarn, whilst those made at Portsmouth and Plymouth used blue and red respectively.



The Maudslay machine travelling down the floor

CLOSING THE ROPE

The last stage of the ropemaking process is that of closing or 'laying' the rope. Most visitors find this the most dramatic operation carried out in the Ropey.

In closing, a number of strands are twisted together to make a rope. Hawser-laid ropes have three strands

and cable-laid ropes have nine (three hawser-laid ropes twisted together). Shroud-laid ropes have four, plus a 'joke' or heart in the middle. Like forming, closing takes place on the ground floor of the Double Ropehouse. Most ropes made at Chatham are hawser-laid, that is they have three strands. Up to three small hawser-laid ropes can be made at a time.

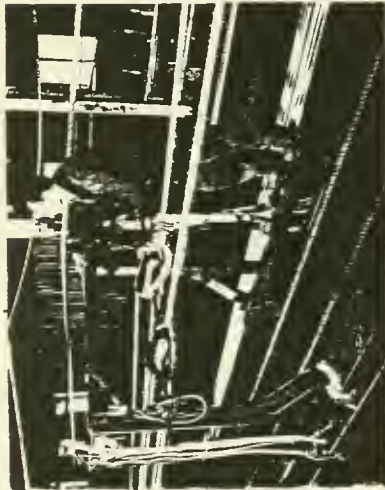
Closing can take place on either side of the Ropewalk. The side nearest to the visitor walkway is for ropes less than 3 in. (76 mm) in circumference. The far side is for ropes of up to 21 in. (600 mm) in circumference. There are two machines on each side. At the south end of the building are the 'standing' machines, and at the north end, mounted on rails, are the 'travelling' machines. Each pair is connected together by a continuous drive rope taken round capstans at the north end of the Ropewalk. Before the introduction of steam power in 1836, they were operated by hand winches. Up to 220 men were needed to close the largest cables. It was said that sometimes men burst blood vessels during this process.



After the hardening process, the ropemakers transfer the strands to a single hook

The strands to be made into rope are laid out along the length of the Ropewalk, supported and kept apart by trestles. Their ends are connected to separate hooks on both the standing and travelling machines. The first stage of the closing process is to 'tension' or 'harden' the strand. This is done by turning the hooks of both machines in a clockwise direction. As the strands are twisted, they shorten and become tense. When the ropemaker in charge judges that sufficient turn has been applied to the strands, the machines are stopped.

At the travelling machine, the ropemakers move the strands to a single hook. The strands remain on separate hooks at the standing machine. A 'top' is inserted between the strands a short distance from the travelling machine. This is a cone-shaped piece of wood with 'scores' or grooves cut into it, one for each strand. The top acts as a guide which causes the strands to come together evenly. Different tops are used for different sizes of rope. The top is fitted onto a rail-mounted cart, known as the 'top cart'.

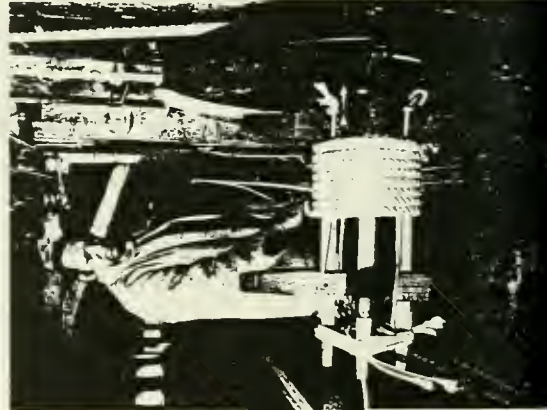


The top cart travelling down the floor

Finally closing can commence. The machines are started, causing the hooks at both ends of the floor to rotate. The travelling machine is put into reverse, so that its hooks now turn in an anti-clockwise direction. The single hook twists the strands together into rope as they pass around the top. This action forces the top cart to move down the floor. The ropemaker in charge travels on the cart, controlling its speed by means of a 'tail' or brake. This is a small piece of rope twisted around the newly formed rope. The ropemaker's skill determines the 'angle of lay' of the rope, as the strands must lay against each other at the correct angle. For hawser-laid rope this angle is 37°.

As the strands combine to form the rope, the distance between the two machines shortens, pulling the travelling machine down the floor. A 'drag' or sledge is towed behind it to maintain tension. Weights are placed on the drag when large ropes are being made.

Coiling the finished rope

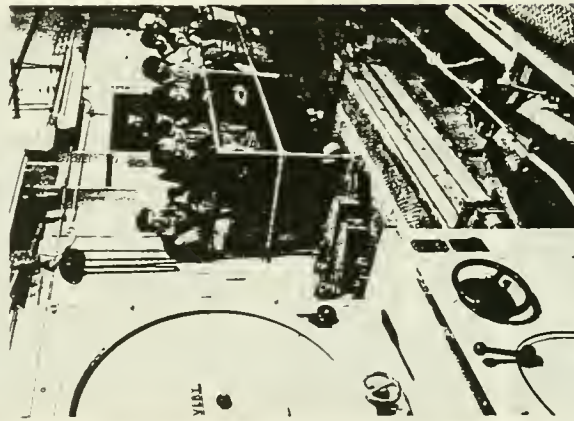


During closing, the strands are twisted together in the opposite direction to that of the forming process. To prevent them from becoming untravelling, the hooks of the standing machine continue to turn in a clockwise direction.

Once the top cart has travelled the length of the Ropewalk, the rope has been made. The ropemakers tie off the ends to prevent them unravelling and cut them off the hooks. The newly made rope is then coiled up on a winding machine. All that remains is to test it.

TESTING

Ropes are often used for tasks in which strengths and reliability are critical. Those made in the Ropery at Chatham go through several quality control tests to make sure that they are up to the required standards.



The testing machine

The main test is for the strength of the whole rope, but other machines test the strength of individual yarns and the effects of wear and tear.

The present rope-testing machine was made by Avery and Sons and was installed in the First House in 1970. A sample of every tenth rope is tested on this machine to make sure that it will not break below the required strength. It is fixed between the machine's jaws, which are then pushed apart by hydraulic rams until the rope breaks. The load exerted by the rams is measured in tons and the point at which the rope snaps is known as its 'breaking strain'. The machine can test ropes with a breaking strain of up to 50 tons.

THE ROPEMAKERS

In the age of sail the ropery was operated as a separate department within the dockyard. It was headed by the Clerk of the Ropery and the Master Ropemaker. The number of people employed in the ropery varied between times of peace and war. A peak was reached during the Napoleonic Wars, when the Royal Navy had more sailing ships than at any other time. In 1808, for example, 304 men worked in the Chatham ropery. Of these, 178 were skilled ropemakers (spinners). There were also apprentices, labourers and 'house boys'.

Just over half of the workforce were employed in hatching and spinning. They were divided into teams known as 'wheels', probably named after the spinning wheels themselves. Each wheel consisted of twenty-seven men and four house boys and looked after a pair of spinning frames. The team included partners, hatchellers, spinners and wheel-turners. It was expected to produce 288 yarns in a day.

A further seventeen men, both spinners and labourers, worked in the Yarn Houses and Tarring House. The remainder, 132 men, formed strands and closed ropes on the Ropewalk.

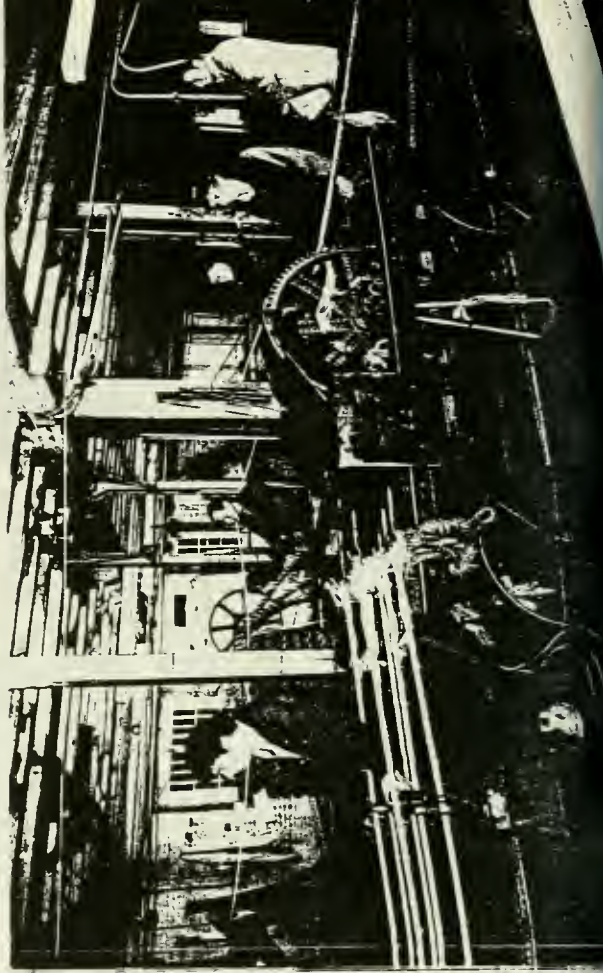
The patron saint of ropemakers is St Catherine of Alexandria and at Chatham there was always a great celebration on St Catherine's Eve (24 November). The ropemakers would hold a procession through the streets of the town begging for apples and beer for the coming festivities.

Today the workforce is much smaller. Numbers were greatly reduced during the nineteenth century, when

The sexes were strictly segregated after the introduction of female labour

steam power and machine spinning were introduced. At the same time sailing vessels were replaced by steam ships, which needed much less rope. By 1892 there were only twenty-four skilled ropemakers in the yard, though by 1913 and the eve of the First World War this figure had risen to thirty-six. The Ropery is now run by Master Ropemakers Ltd, a company owned by the Chatham Historic Dockyard Trust. Around twelve people are now employed, working in the Spinning Room and Ropewalk.

Some of today's ropemakers



APPENDIX D

IMPACTS ON THE INFRASTRUCTURE SYSTEMS WITHIN THE NAVY YARD

APPENDIX D
IMPACTS ON THE INFRASTRUCTURE SYSTEMS
WITHIN THE NAVY YARD

The impacts of the proposed redevelopment of the Charlestown Navy Yard on infrastructure systems bordering and serving the site were evaluated in the Draft Supplemental Environmental Impact Report (DSEIR), submitted to MEPA in June, 1991. The purpose of this report is to evaluate the impacts on the infrastructure systems within the Navy Yard. Sanitary sewer, water, and storm drain demands are evaluated for existing conditions and Phase I and Phase II build-out. Project impacts on the Navy Yard's sanitary sewer and water distribution systems are evaluated based on Title 5¹ estimates of waste water generation and water demands. Mitigation measures, if necessary, are identified.

1. EXISTING CONDITIONS

Sanitary Sewers

The routing of the sanitary sewer system within the Navy Yard is illustrated on Figure 1. Much of this system has been constructed since 1980, and as this report shows, the existing system is adequate to satisfy the requirements of the Navy Yard

¹ Wherever possible, Title 5 of the State Environmental Code (310 CMR 15.00) has been used for sewage flow estimates. In these cases, water demand was estimated at 110 % of the Title 5 sewage flow. For the research facilities, six months of actual water use data for the existing facility were used to make estimates of maximum daily water demand and sewage generation. Marina water use and sewage generation were based on standard estimating factors promulgated by the Commonwealth of Virginia State Board of Health in Title 32, Article 1, Section 4.06 - Marinas.

redevelopment project. The Navy Yard sanitary sewer system conveys flows to the Charlestown Branch Sewer which passes through the Navy Yard. Flows are carried on-site primarily by 10-inch, 12-inch, and 15-inch sewers. Connections to the Charlestown Branch Sewer are at manholes near the intersection of Fifth Street and 2nd Avenue (Southern Route), and at the intersection of Sixth Street and 3rd Avenue (Northern Route). The Charlestown Branch Sewer is owned by the Massachusetts Water Resources Authority (MWRA). Existing conditions of the Charlestown Branch Sewer are described in Section C.1 of Chapter 5 of the DSEIR.

The capacity of the Southern Route sewer system has been determined as shown in Table 1. The Southern Route begins at Manhole 46 at the intersection of Sixteenth Street and 1st Avenue. A 10-inch sewer proceeds under 1st Avenue from this manhole, expands to a 12-inch sewer at Manhole 44, and to a 15-inch sewer at Manhole 518. Connections to the sewer on 1st Avenue are at Manhole 34 for a 12-inch sewer expanded from a 10-inch sewer under Ninth Street; at Manhole 518 for a 10-inch sewer under Eighth Street; and at Manhole 519 for a 10-inch sewer under Seventh Street.

The 15-inch sewer under 1st Avenue continues from Manhole 485, and turns northwest under Sixth Street and proceeds to Manhole 483 at the intersection with 2nd Avenue. The sewer on 2nd Avenue originates at Manhole 511. This 10-inch sewer expands to a 15-inch sewer at Manhole 483, proceeds under 2nd Avenue, and intercepts the Charlestown Sewer Branch at Manhole 482 near the intersection of Fifth Street.

The capacity of the Northern Route has been determined as shown in Table 2. The Northern Route begins at Manhole 51 on Sixteenth Street near the intersection of 5th

Avenue. A 10-inch sewer proceeds from this manhole under Sixteenth Street to Manhole 48 at the intersection with 2nd Avenue. A 10-inch sewer proceeds under 2nd Avenue from Manhole 48 to Manhole 64 near the intersection with Ninth Street. A connection to the sewer in 2nd Avenue is made at Manhole 50 at the intersection of Thirteenth Street. This 10-inch sewer originates at Manhole 18, proceeds under 5th Avenue to Manhole 22, and then proceeds under Thirteenth Street to Manhole 50.

The Northern Route sewer turns under Ninth Street from Manhole 64 and proceeds to Manhole 65 at the intersection with 3rd Avenue. The 10-inch sewer expands to a 12-inch sewer at Manhole 65 and proceeds under 3rd Avenue. At Manhole 509, the sewer expands to a 15-inch sewer, proceeds under Third Street and intercepts the Charlestown Sewer Branch at Manhole 261 at the intersection with Sixth Street.

Existing waste water generation from residential, commercial, and other sources within the Navy Yard are detailed in Section C.1 of Chapter 5 of the DSEIR. Total existing maximum waste water generation is estimated at 409,700 gallons per day (gpd). Total existing instantaneous peak waste water generation is estimated at 569 gallons per minute (gpm).

TABLE 1

CHARLESTOWN NAVY YARD

SANITARY SEWER CAPACITY EVALUATION

SOUTHERN ROUTE

| <u>Segment
Manhole to
Manhole</u> | <u>Segment
Size
(in.)</u> | <u>Length
(ft)</u> | <u>Slope
(ft/ft)</u> | <u>Capacity
(MGD)</u> |
|---|-----------------------------------|------------------------|--------------------------|---------------------------|
| 46 - 45 | 10 | 515 | 0.0057 | 1.07 |
| 45 - 44 | 10 | 90 | 0.0047 | 0.97 |
| 44 - 33 | 12 | 286 | 0.0048 | 1.60 |
| 33 - 34 | 12 | 155 | 0.0035 | 1.37 |
| 28 - 29 | 10 | 118 | 0.0075 | 1.23 |
| 29 - 30 | 10 | 61 | 0.0079 | 1.26 |
| 30 - 31 | 10 | 164 | 0.0065 | 1.14 |
| 31 - 32 | 10 | 203 | 0.0058 | 1.08 |
| 32 - 34 | 10 | 172 | 0.0024 | 0.69 |
| 34 - 35 | 12 | 247 | 0.0036 | 1.38 |
| 53 - 518 | 12 | 143 | 0.0037 | 1.40 |
| 86 - 40 | 10 | 95 | 0.0064 | 1.14 |
| 40 - 39 | 10 | 98 | 0.0070 | 1.19 |
| 39 - 38 | 10 | 306 | 0.0066 | 1.15 |
| 38 - 37 | 10 | 125 | 0.0060 | 1.10 |
| 37 - 36 | 10 | 65 | 0.0057 | 1.07 |
| 36 - 518 | 10 | 242 | 0.0051 | 1.01 |
| 518 - 519 | 15 | 91 | 0.0032 | 2.36 |
| 515 - 519 | 10 | 118 | 0.0161 | 1.80 |
| 519 - 520 | 15 | 35 | 0.0026 | 2.12 |
| 520 - 485 | 15 | 232 | 0.0029 | 2.27 |
| 485 - 483 | 15 | 105 | 0.0048 | 2.89 |
| 511 - 484 | 10 | 165 | 0.0244 | 2.22 |
| 510 - 484 | 10 | 40 | 0.0167 | 1.83 |
| 484 - 483 | 10 | 265 | 0.0128 | 1.61 |
| 483 - 482 | 15 | 110 | 0.0025 | 2.11 |
| 477 - 478 | 10 | 140 | 0.0121 | 1.56 |
| 478 - 521 | 16 | 94 | 0.0120 | 5.45 |
| 521 - 482 | 16 | 15 | 0.0120 | 5.44 |

TABLE 2

CHARLESTOWN NAVY YARDSANITARY SEWER CAPACITY EVALUATIONNORTHERN ROUTE

| <u>Segment
Manhole to
Manhole</u> | <u>Segment
Size
(in.)</u> | <u>Length
(ft)</u> | <u>Slope
(ft/ft)</u> | <u>Capacity
(MGD)</u> |
|---|-----------------------------------|------------------------|--------------------------|---------------------------|
| 51 - 48 | 10 | 300 | 0.0060 | 1.10 |
| 47 - 48 | 10 | 58 | 0.0048 | 0.91 |
| 48 - 49 | 10 | 170 | 0.0046 | 0.96 |
| 49 - 50 | 10 | 325 | 0.0050 | 1.00 |
| 18 - 19 | 10 | 25 | 0.0400 | 2.84 |
| 19 - 21 | 10 | 91 | 0.0057 | 1.07 |
| 20 - 21 | 6 | 32 | 0.0719 | 0.97 |
| 21 - 22 | 10 | 105 | 0.0058 | 1.08 |
| 23 - 22 | 10 | 55 | 0.0055 | 1.05 |
| 22 - 24 | 10 | 115 | 0.0099 | 1.41 |
| 25 - 24 | 6 | 30 | 0.0720 | 0.98 |
| 24 - 50 | 10 | 275 | 0.0062 | 1.12 |
| 50 - 63 | 10 | 478 | 0.0041 | 0.90 |
| 63 - 64 | 10 | 40 | 0.0030 | 0.78 |
| 64 - 65 | 10 | 65 | 0.0046 | 0.96 |
| 55 - 65 | 10 | 112 | 0.0348 | 2.65 |
| 65 - 481 | 12 | 283 | 0.0035 | 1.36 |
| 481 - 509 | 12 | 35 | 0.0143 | 2.76 |
| 509 - 479 | 15 | 185 | 0.0019 | 1.82 |
| 479 - 261 | 15 | 138 | 0.0048 | 2.89 |

Water

The Charlestown Navy Yard is supplied with potable and fire service water by the Boston Water and Sewer Commission's Northern Low Service system. The primary source of water to the project area is a 36-inch main running under the Charles River from downtown Boston. The 36-inch main connects to and supplies a 24-inch line near the intersection of Main and Chelsea Streets in Charlestown. The 24-inch main was replaced in the mid-1980s when the street was rebuilt. Available flow and pressure within the project area is assumed to be extremely good because of the large diameter connection to the city system. Hydrant test results in the Navy Yard support this assumption (see Table 3).

The Navy Yard is tied into the 24-inch main in Chelsea Street by 16-inch mains near the Marine Barracks and at the northeastern end of the Yard near Medford Street. These connections and the water distribution lines for the Navy Yard are shown in Figure 2.

Existing water demand in the Charlestown Navy Yard consists of water use by residential and commercial (office and retail) customers as well as by the MGH Biomedical Research Facility. A breakdown of existing water use was given in the DSEIR and was estimated to be 450,700 gallons per day.

An analysis was performed to determine if the water distribution system is adequate to accommodate the existing and projected water demands of the Navy Yard redevelopment project. The analysis employs a computerized model that simulates the

Yard's water distribution system as a system of links and nodes and predicts static water pressures at the distribution system withdrawal points and hydrants (nodes) and flow rates within the network pipes (links). Details of the model are described further in the Future Impacts and Mitigation - Water section.

The model has been calibrated and verified by comparing output residual pressures with known hydrant residual pressure. Recent test data from the Boston Water and Sewer Commission, available from three hydrants in the Navy Yard, were compared to the results of the peak use period distribution model simulation for hydrants within the Navy Yard. As shown in Table 3, modelled results correlate well with the limited hydrant test data available in the Navy Yard.

The results of the peak use period distribution model simulation for all demand points within the Navy Yard indicate adequate flow with static pressure of at least 65 psi and residual pressure of at least 61 psi (Table 3). Simulation of the Navy Yard water distribution system indicates that the existing development does not have an adverse impact on static water pressure in the supply or distribution lines.

Storm Drains

Storm sewers and sanitary sewers in the Charlestown Navy Yard were separated during redevelopment in the early 1980's. The routing for the storm drain system within the Navy Yard is illustrated on Figure 3. The direction of flow and size of each drainage line are also indicated on Figure 3. The majority of storm flows from the Navy Yard are directed to outfalls located at the Little Mystic

TABLE 3

COMPARISON OF MEASURED HYDRANT TEST DATA
WITH WATER DISTRIBUTION MODEL RESULTS FOR EXISTING NAVY YARD

| <u>Date</u> | <u>Location</u> | <u>Residual Pressure</u> | | Fire
Flow*
(gpm) |
|-------------|-------------------------------|-------------------------------|-------------------------------------|------------------------|
| | | <u>Hydrant
Test (psi)</u> | <u>Distribution
Model (psi)</u> | |
| 9/24/87 | Ninth Street | 63 | 61.7 | 6705 |
| 9/23/88 | Building 197 | 61 | 61.7 | 5358 |
| 9/24/88 | Sixteenth Street @ 5th Avenue | 62 | 62.5 | 6255 |

*Estimated flow available at residual pressure of 20 psi - an index generally used by water companies for fire flow conditions.

Channel. Storm flows from the Sixth Street area are directed to outfalls at Boston Inner Harbor on the perimeter of the Navy Yard, between Piers 3 and 4. This drainage system includes storm flow that originates upstream of the Navy Yard.

2. FUTURE IMPACTS AND MITIGATION

Sanitary Sewers

Projected future waste water generation associated with the proposed completion of Phase I and Phase II of the Charlestown Navy Yard are detailed in Section C.2 of Chapter 5 of the DSEIR. Phase I development will result in an estimated maximum increase in waste water generation of approximately 333,300 gpd. The instantaneous peak increase for Phase I is estimated at 463 gpm. Phase II development will result in an estimated maximum increase in waste water generation of approximately 186,900 gpd, and an instantaneous peak increase of 260 gpm. Total build-out (existing and Phases I and II) waste water generation is estimated at a maximum of 929,900 gpd, and an instantaneous peak of 1292 gpm. Phase I and Phase II development, in total, will contribute a maximum increase in waste water flow of 127 percent above existing conditions.

The capacities of the sanitary systems within the Navy Yard were assessed to determine if the systems have the available capacities to accommodate waste water flows from Phases I and II developments. Waste water flows from sources within the Navy Yard were applied to the nearest sewer route. Waste water flows from Parcel 6, located near both Southern and Northern Route sewer lines, were applied to the Southern Route.

Based on the total capacities of the sewer systems, and the existing waste water flows, available capacities were determined.

The capacity of the Northern Route is limited by a run of sewer line between Manholes 63 and 64, at the intersection of 2nd Avenue and Ninth Street. At this section of the sewer system, instantaneous peak waste water generation from Phases I and II developments require 81 percent of the available capacity. For the Southern Route, the maximum requirement of available capacity is at sewer lines along First Avenue, where waste water flows from Phases I and II require between 28 to 45 percent of the available capacity. In addition, between Manholes 483 and 482 along Second Street at the intercept of the Charlestown Branch Sewer, Phase I and Phase II waste water flows require 37 percent of the available capacity. The above assessment assumes that sufficient capacity is available without surcharging of manholes. Any surcharge conditions due to future projects is expected to be mitigated by the developer of those future projects.

Water

In addition to the existing demand, projected future water demand consists of demand associated with the proposed additional development of Phases I and II. As summarized in the DSEIR, the estimated maximum water demand after Phase I is 817,300 gallons per day (gpd), and the total estimated full development water demand is 1,023,100 gpd.

The same analysis as used in the existing water section was performed using the

peak demands of Phase I in addition to the existing project. The model performs an analysis of the flow and pressure distributions in the Navy Yard water system using the Hardy Cross method. The method is a simple, efficient iterative method that is suitable for most applications. The method begins by assuming an initial flow distribution in the network (flow from the two 16-inch mains into the Navy Yard) which is estimated from recent hydrant tests conducted by the Boston Water and Sewer Commission in the area. Projected flow due to the demands at individual buildings in the Yard (nodes) was input into the model. The imbalance in the pressure and flow of the Navy Yard water system was computed and corrections made to the flow rates in each loop. Convergence is said to be reached when the largest correction is less than a pre-defined tolerance level.

Sustainable water pressure at the two 16-inch mains which deliver water supply to the Yard is estimated to be approximately 65 psi based on hydrant tests outside the Navy Yard area. Peak demands of the individual buildings are based on two times the capacities calculated by the Title V factors (see DSEIR for explanation of water use estimates). Minor loss coefficients due to tees, elbows, size changes, and valves, and a roughness factor for the pipes are incorporated into the Hardy Cross model. The results of the peak use period distribution model simulation for all demand points within the Navy Yard indicate adequate flow with static pressure of at least 64.5 psi which is far in excess of the 20 psi necessary to meet fire flow requirements.

Simulation of the Navy Yard's water distribution system shows that the proposed Phase I project in addition to the existing project does not have a significant impact on static water pressure in the supply or distribution lines.

The same analysis was performed for total build-out of the Navy Yard (existing plus Phases I and II). The results of the peak use period distribution model simulation for all demand points within the Navy Yard indicate adequate flow with static pressure of at least 64 psi. Simulation of the Navy Yard's water distribution system shows that the total build-out project does not have a significant impact on static water pressure in the supply or distribution lines. The analysis indicates that the existing water distribution system is adequate to serve the anticipated level of development in the Navy Yard. Fire flow requirements will be met at total build-out since the residual system pressure will far exceed the residual pressure required for fire protection of 20 psi. As shown in Table 3, for a fire flow requirement of approximately 2000 gpm at 20 psi, the existing distribution lines have an excess capacity of at least 5300 gpm at 20 psi.

Storm Drains

Any new storm drainage constructed as part of the proposed development will incorporate collection systems conforming with good engineering practice in order to mitigate releases of silt and oil to the receiving waters. In particular, oil/grease traps will be installed in the systems in conformance with the requirements of the Boston Water and Sewer Commission (BWSC) and the MWRA.

Storm flows from within the Navy Yard after redevelopment are expected to be less than that of existing conditions, due to an increase in the area of permeable ground surface associated with the plan for development of the Yard's End.



LITTLE MYSTIC CHANNEL

CHARLESTOWN

CHARLESTOWN
BRANCH SEWER

CHELSEA

CHARLESTOWN
BRANCH SEWER

7th AVENUE

4th AVE

1st AVE

2nd AVE

5th AVE

6th AVE

7th AVE

8th AVE

9th AVE

10th AVE

11th AVE

12th AVE

13th AVE

14th AVE

15th AVE

16th AVE

17th AVE

18th AVE

19th AVE

20th AVE

21st AVE

22nd AVE

23rd AVE

24th AVE

25th AVE

26th AVE

27th AVE

28th AVE

29th AVE

30th AVE

31st AVE

32nd AVE

33rd AVE

34th AVE

35th AVE

36th AVE

37th AVE

38th AVE

39th AVE

40th AVE

41st AVE

42nd AVE

43rd AVE

44th AVE

45th AVE

46th AVE

47th AVE

48th AVE

49th AVE

50th AVE

51st AVE

52nd AVE

53rd AVE

54th AVE

55th AVE

56th AVE

57th AVE

58th AVE

59th AVE

60th AVE

61st AVE

62nd AVE

63rd AVE

64th AVE

65th AVE

66th AVE

67th AVE

68th AVE

69th AVE

70th AVE

71st AVE

72nd AVE

73rd AVE

74th AVE

75th AVE

76th AVE

77th AVE

78th AVE

79th AVE

80th AVE

81st AVE

82nd AVE

83rd AVE

84th AVE

85th AVE

86th AVE

87th AVE

88th AVE

89th AVE

90th AVE

91st AVE

92nd AVE

93rd AVE

94th AVE

95th AVE

96th AVE

97th AVE

98th AVE

99th AVE

100th AVE

101st AVE

102nd AVE

103rd AVE

104th AVE

105th AVE

106th AVE

107th AVE

108th AVE

109th AVE

110th AVE

111th AVE

112th AVE

113th AVE

114th AVE

115th AVE

116th AVE

117th AVE

118th AVE

119th AVE

120th AVE

121st AVE

122nd AVE

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124th AVE

125th AVE

126th AVE

127th AVE

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131st AVE

132nd AVE

133rd AVE

134th AVE

135th AVE

136th AVE

137th AVE

138th AVE

139th AVE

140th AVE

141st AVE

142nd AVE

143rd AVE

144th AVE

145th AVE

146th AVE

147th AVE

148th AVE

149th AVE

150th AVE

151st AVE

152nd AVE

153rd AVE

154th AVE

155th AVE

156th AVE

157th AVE

158th AVE

159th AVE

160th AVE

161st AVE

162nd AVE

163rd AVE

164th AVE

165th AVE

166th AVE

167th AVE

168th AVE

169th AVE

170th AVE

171st AVE

172nd AVE

173rd AVE

174th AVE

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218th AVE

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261st AVE

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263rd AVE

264th AVE

265th AVE

266th AVE

267th AVE

268th AVE

269th AVE

270th AVE

271st AVE

272nd AVE

273rd AVE

274th AVE

275th AVE

276th AVE

277th AVE

278th AVE

279th AVE

280th AVE

281st AVE

282nd AVE

283rd AVE

284th AVE

285th AVE

286th AVE

287th AVE

288th AVE

289th AVE

290th AVE

291st AVE

292nd AVE

293rd AVE

294th AVE

295th AVE

296th AVE

297th AVE

298th AVE

299th AVE

300th AVE

301st AVE

302nd AVE

303rd AVE

304th AVE

305th AVE

306th AVE

307th AVE

308th AVE

309th AVE

310th AVE

311th AVE

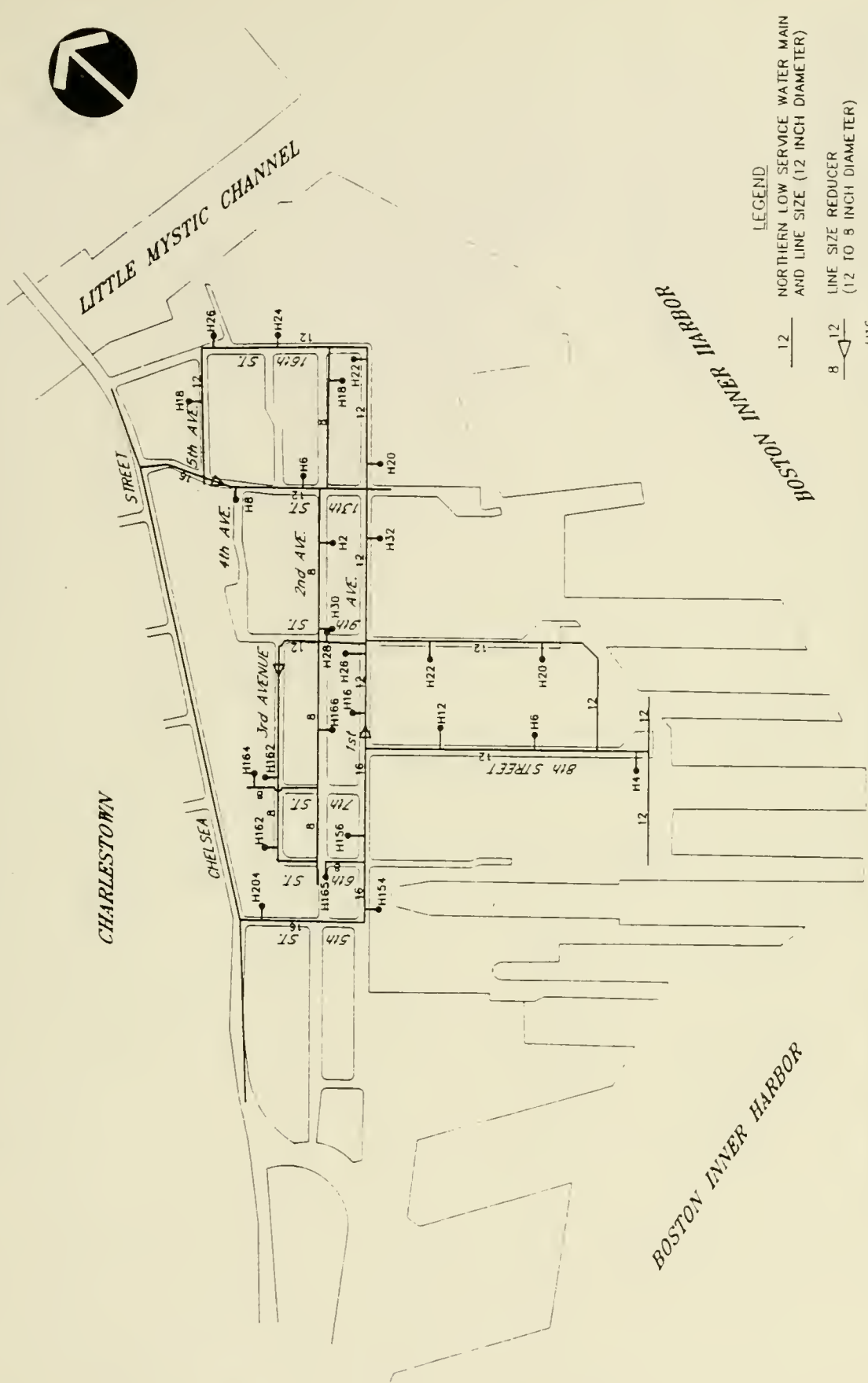
312th AVE

313th AVE

314th AVE

315th AVE

<



LEGEND

- 12 — NORTHERN LOW SERVICE WATER MAIN AND LINE SIZE (12 INCH DIAMETER)
- 8 — LINE SIZE REDUCER (12 TO 8 INCH DIAMETER)
- H16 — HYDRANT AND IDENTIFICATION NUMBER

FIGURE 2
WATER DISTRIBUTION SYSTEM
CHARLESTOWN NAVY YARD



LITTLE MYSTIC CHANNEL

CHARLESTOWN

STREET

CHELSEA

5th AVE.

4th AVE.

3rd AVENUE

2nd AVE.

1st AVE.

8th STREET

BOSTON INNER HARBOR

BOSTON INNER HARBOR

LEGEND

DIRECTION OF FLOW AND SIZE OF
LINE (48 INCH DIAMETER) BETWEEN
NODE POINTS



FIGURE 3
STORM DRAIN SYSTEM
CHARLESTOWN NAVY YARD

APPENDIX E
MESOSCALE AIR QUALITY ANALYSIS

gov 91-2296

MESOSCALE AIR QUALITY ANALYSIS --
FOR THE CHARLESTOWN NAVY YARD REDEVELOPMENT

Prepared for:

Boston Redevelopment Authority
One City Hall Square
Boston, MA 02201

Prepared by:

Tech Environmental, Inc.
Reservoir Place
1601 Trapelo Road
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(617) 890-2220

August 1991

AIR QUALITY

A mesoscale analysis estimates the daily release of hydrocarbons (a precursor to ozone) from motor vehicles in a certain study area in order to quantify the effects of a project or action on areawide hydrocarbon emissions. The calculation includes how many miles of travel occur and how much hydrocarbon is released for each mile of travel. Mesoscale analyses have traditionally been performed for highway construction projects on a large, regional scale. The analysis is not well suited to individual development projects and the small study areas in which they influence traffic volumes.

The ozone formation process involves emissions from multi-state areas covering distances of hundreds of kilometers, and time scales of 1 to 3 days. The total hydrocarbon emissions from all activities in Massachusetts are roughly 1.1 million kg/day (DEP Base Year Inventory, February 1991). The net effect of the traffic from the additional development at the Charlestown Navy Yard with implementation of the Proposed Plan is an increase of about 9 to 10 kg/day in both 1998 and 2005, with mitigation. Thus, in terms of the regional emissions which determine ozone concentrations, the effects of this project are clearly insignificant (less than 0.0008% increase). Much of this increase will be offset by the removal of Aquarium visitor trips from the downtown waterfront area where the Aquarium is now located. Nonetheless, MEPA has requested that the mesoscale analysis be done to quantify the change in hydrocarbon emissions.

MESOSCALE ANALYSIS

Study Area

The mesoscale study area was defined in accordance with DEP guidance to include all roadway links that will potentially experience an increase of ten per cent (10%) in traffic due to the project. The study area used in this analysis was approved by DEP staff¹ and is shown in Figure 1. Table 1 lists these links. The scenarios modeled in this analysis are:

1. 1991 Existing Conditions
2. 1998 Approved Plan
3. 1998 Proposed Plan
4. 2005 Approved Plan
5. 2005 Proposed Plan

¹ Personal communication, Mr. Jon Anderson, DEP, August 9, 1991.

Presentation of Data and Results

Traffic volumes used in the analysis were presented in the June 1991 Charlestown Navy Yard Redevelopment Draft Supplemental Environmental Impact Report (DSEIR). The DSEIR presents AM and PM peak hour (summertime) volumes for the four future scenarios and the existing scenario. However, Annual Average Weekday Daily Traffic (AAWDT) volumes were presented in the DSEIR for only the existing scenario. The relationship between summer PM peak hour volumes and AAWDT volumes were determined for each link for the existing scenario, and this was applied to calculate AAWDT volumes for each link, for each future scenario, from the PM peak volumes. These calculated AAWDT values are shown in Tables 2, 3 and 4 for the 1991, 1998 and 2005 scenarios, respectively.

Average daily vehicle speeds and link lengths were provided by TAMS Consultants, Inc. Link lengths are listed in Table 2, 3 and 4, and average daily vehicle speeds are listed in Table 5. AAWDT volumes were multiplied by each link length to yield the vehicle miles traveled (VMT) on a link by link basis for all scenarios. Emission factors for non-methane hydrocarbons (NMHC) at these speeds were generated from the U.S. EPA MOBILE4.1 emissions factor computer model and are also listed in Table 5. All MOBILE4.1 inputs were in accordance with the DEP/Division of Air Quality Control guidance memo (dated June 20, 1991) for mesoscale analyses. The MOBILE4.1 output has been included as Figure 2. The emission factor was then multiplied by the VMT for each link to get a total NMHC emissions for each link in kg/day.

The mesoscale analysis results are presented in Table 6. The total NMHC emissions in the study area are predicted to be 17.38 kg/day (0.019 tons/day) for the 1991 Existing Conditions, 32.97 kg/day (0.036 tons/day) for the 1998 Approved Plan, 42.46 kg/day (0.047 tons/day) for the 1998 Proposed Plan, 29.99 kg/day (0.033 tons/day) for the 2005 Approved Plan and 40.38 kg/day (0.045 tons/day) for the 2005 Proposed Plan.

Mitigation Measures

The EIR for the Navy Yard Redevelopment is different than the typical submission MEPA receives from a developer where first the traffic impacts are presented and then later a mitigation package is negotiated. The BRA has developed a comprehensive land use and transportation plan in an iterative process for the Navy Yard, and at each step the possible land uses have been examined as to how they can be accommodated with the transportation infrastructure that is available--roadway and public transit. Thus, mitigation of traffic impacts have been considered in advance during the land use planning process. While this is the ideal approach for redevelopment, it does not present the usually clear lines between development and mitigation.

The results from the mesoscale analysis show that the NMHC emissions for the 1998 and 2005 Proposed Plan scenarios are expected to be 9.49 kg/day and 10.39 kg/day more than the respective 1998 and 2005 Approved Plan scenarios. Due to that fact all reasonable and feasible traffic mitigation measures were included up-front in the traffic projections for the Proposed Plan, the 9-10 kg/day increases in NMHC are already reduced for the effects of mitigation.

To minimize and reduce the potential mesoscale air quality impacts of the Navy Yard Redevelopment, the choices are reducing the number of vehicle trips or reducing the emissions from individual motor vehicles. To reduce the project's trip generation, a Transportation Management Association (TMA) will be formed in the Charlestown Navy Yard and will implement an extensive Traffic Demand Reduction Plan that has been developed and discussed in detail in the DSEIR.

The second option for decreasing NMHC emissions is to decrease the tailpipe emissions of each car. This could be done through increasing vehicle speeds, which has adverse safety implications, or by shifting the vehicle population from older to newer cars, a tact that is not within the proponent's control. Therefore, the mitigation measures listed above--travel demand reduction, public transportation incentives--are the most reasonable and feasible hydrocarbon mitigation measures.

Without the mitigation measures described above, it is clear there would be significantly higher increases in traffic. It is not possible, however, to accurately quantify the benefits of this mitigation because the Proposed Plan could not supply adequate parking spaces if transit were not used, for example. It should also be noted that the 9-10 kg/day NMHC increase is further offset by the removal of Aquarium visitor trips (1.3 million/year) from the downtown waterfront area where the Aquarium is now located. Again, although a separate transportation analysis has not been done to quantify the decrease in motor vehicle trips at the existing Aquarium site, which is outside the study area, it is reasonable to assume that the offset will cancel out much of the 9-10 kg/day increase that is predicted for the Navy Yard, after mitigation.

J777R1

TABLE 1

ROADWAY LINKS INCLUDED IN THE
MESOSCALE STUDY AREA

Link No./Link Name

-
1. 16th Street (to Chelsea Street)*
 2. Chelsea Street (Terminal Street to 16th Street)**
 3. Chelsea Street (16th Street to 13th Street)
 4. Chelsea Street (13th Street to Medford Street)
 5. Chelsea Street (Medford Street to Vine Street)
 6. Chelsea Street (Vine Street to 5th Street)
 7. 5th Street (to Chelsea Street)
 8. Chelsea Street (5th Street to City Square)
 9. I-93 On Ramp
-

* - exists only under the Proposed scenarios.

** - from the overflow parking lot on Terminal Street to 16th Street.

TABLE 2

VEHICLE MILES TRAVELED (VMT)
IN THE MESOSCALE STUDY AREA, YEAR 1991

| Link No. | Link Length
(miles) | AAWDT - Year 1991
(vehicles/day)
existing | VMT - Year 1991
(vehicle-miles/day)
existing |
|----------|------------------------|---|--|
| 1 | 0.142 | 0. | 0. |
| 2 | 0.176 | 766. | 135. |
| 3 | 0.076 | 766. | 58. |
| 4 | 0.028 | 6,368. | 178. |
| 5 | 0.172 | 5,227. | 899. |
| 6 | 0.074 | 7,930 | 587. |
| 7 | 0.085 | 5,620. | 478. |
| 8 | 0.360 | 10,610. | 3,820. |
| 9 | 0.076 | 0. | 0. |

TABLE 3

VEHICLE MILES TRAVELED (VMT)
IN THE MESOSCALE STUDY AREA, YEAR 1998

| Link
No. | Link Length
(miles) | AAWDT - Year 1998
(vehicles/day) | | VMT - Year 1998
(vehicle-miles/day) | |
|-------------|------------------------|-------------------------------------|------------------|--|------------------|
| | | approved
plan | proposed
plan | approved
plan | proposed
plan |
| 1 | 0.142 | 0. | 15,783. | 0. | 2,241. |
| 2 | 0.176 | 711. | 1,772. | 125. | 312. |
| 3 | 0.076 | 871. | 12,032. | 66. | 914. |
| 4 | 0.028 | 11,118. | 13,022. | 311. | 365. |
| 5 | 0.172 | 10,333. | 12,229. | 1,777. | 2,103. |
| 6 | 0.074 | 17,900. | 20,935. | 1,325. | 1,549. |
| 7 | 0.085 | 9,683. | 9,517. | 823. | 809. |
| 8 | 0.360 | 36,271. | 39,441. | 13,058. | 14,199. |
| 9 | 0.076 | 23,458. | 26,169. | 1,783. | 1,989. |

TABLE 4

VEHICLE MILES TRAVELED (VMT)
IN THE MESOSCALE STUDY AREA, YEAR 2005

| Link
No. | Link Length
(miles) | AAWDT - Year 2005
(vehicles/day) | | VMT - Year 2005
(vehicle-miles/day) | |
|-------------|------------------------|-------------------------------------|------------------|--|------------------|
| | | approved
plan | proposed
plan | approved
plan | proposed
plan |
| 1 | 0.142 | 0. | 17,617. | 0. | 2,501. |
| 2 | 0.176 | 746. | 2,026. | 131. | 357. |
| 3 | 0.076 | 914. | 13,527. | 69. | 1,028. |
| 4 | 0.028 | 11,462. | 9,452. | 321. | 265. |
| 5 | 0.172 | 10,688. | 13,604. | 1,838. | 2,340. |
| 6 | 0.074 | 18,553. | 23,250. | 1,373. | 1,721. |
| 7 | 0.085 | 9,900. | 10,650. | 842. | 905. |
| 8 | 0.360 | 38,271. | 43,356. | 13,778. | 15,608. |
| 9 | 0.076 | 25,186. | 28,475. | 1,914. | 2,164. |

TABLE 5

NON-METHANE HYDROCARBON (NMHC) EMISSIONS
IN THE MESOSCALE STUDY AREA

| Link
No. | Avg.
Daily
Veh.
Speed
(mph) | 1991
Emission
Factor
g/mile | 1998
Emission
Factor
(g/mile) | 2005
Emission
Factor
(g/mile) | Emissions
-1991. | | Emissions - 1998
(kg/day) | | Emissions - 2005
(kg/day) | |
|-------------|---|--------------------------------------|--|--|---------------------|--|------------------------------|------------------|------------------------------|------------------|
| | | | | | Existing | | Approved
Plan | Proposed
Plan | Approved
Plan | Proposed
Plan |
| 1 | 20 | 3.178 | 2.007 | 1.743 | 0.00 | | 0.00 | 4.50 | 0.00 | 4.36 |
| 2 | 25 | 2.734 | 1.678 | 1.452 | 0.37 | | 0.21 | 0.52 | 0.19 | 0.52 |
| 3 | 25 | 2.734 | 1.678 | 1.452 | 0.16 | | 0.11 | 1.53 | 0.10 | 1.49 |
| 4 | 25 | 2.734 | 1.678 | 1.452 | 0.49 | | 0.52 | 0.61 | 0.47 | 0.38 |
| 5 | 25 | 2.734 | 1.678 | 1.452 | 2.46 | | 2.98 | 3.53 | 2.67 | 3.40 |
| 6 | 25 | 2.734 | 1.678 | 1.452 | 1.60 | | 2.22 | 2.60 | 1.99 | 2.50 |
| 7 | 15 | 3.886 | 2.467 | 2.132 | 1.86 | | 2.03 | 2.00 | 1.79 | 1.93 |
| 8 | 25 | 2.734 | 1.678 | 1.452 | 10.44 | | 21.91 | 23.83 | 20.00 | 22.66 |
| 9 | 25 | 2.734 | 1.678 | 1.452 | 0.00 | | 2.99 | 3.34 | 2.78 | 3.14 |

TABLE 6

TOTAL NMHC EMISSIONS BURDEN

1991 Existing

17.38 kg/day
(0.019 tons/day)

1998 Approved Plan

32.97 kg/day
(0.036 tons/day)

1998 Proposed Plan

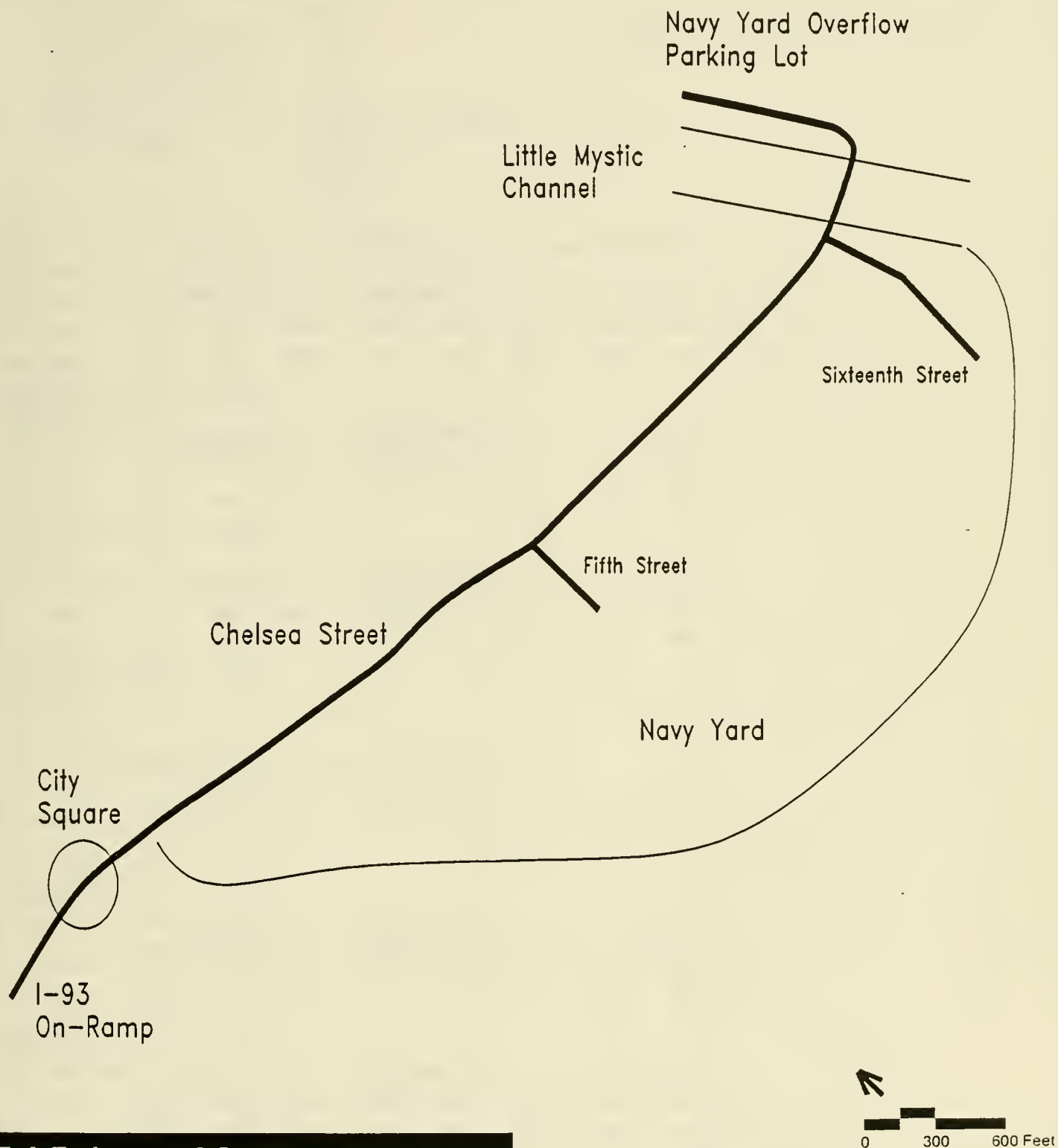
42.46 kg/day
(0.047 tons/day)

2005 Approved Plan

29.99 kg/day
(0.033 tons/day)

2005 Proposed Plan

40.38 kg/day
(0.045 tons/day)



Tech Environmental, Inc.

Reservoir Place
1601 Trapelo Road
Waltham, MA 02154

Mesoscale Analysis
Study Area Links

Figure 1

MOBILE SOURCE EMISSIONS - BRA NAVY YARD, BOSTON

I/M program selected:

Start year (January 1): 1983
 Pre-1981 MTR stringency rate: 12%
 First model year covered: 1977
 Last model year covered: 2005
 Waiver rate (pre-1981): 1%
 Waiver rate (1981 and newer): 1%
 Compliance Rate: 85%
 Inspection type: Computerized decentralized
 Inspection frequency: Annual
 Vehicle types covered: LDGV - Yes
 LDGT1 - Yes
 LDGT2 - Yes
 HDGV - No

Figure 2. Mobile4.1 Output.

1981 & later MTR test type:

Idle

NAVY YARD REDEV

Period 1 RVP: 11.5

Minimum Temp: 87. (F)

Maximum Temp: 88. (F)

Period 2 RVP: 9.0

Period 2 Start Yr: 1989

Non-methane HC emission factors include evaporative HC emission factors.

| Cal. Year: 1991 | I/M Program: Yes | | | Ambient Temp: 88.0 (F) | | | Region: Low | | | | |
|--------------------------------------|-----------------------|-------|-------|------------------------------------|-------|-------|--------------------|-------|-------|---------|--|
| | Anti-tam. Program: No | | | Operating Mode: 20.6 / 27.3 / 20.6 | | | Altitude: 500. Ft. | | | | |
| Veh. Type: | LDGV | LDGT1 | LDGT2 | LDGT | HDGV | LDDV | LDDT | HDDV | MC | All Veh | |
| Veh. Speeds: | 15.0 | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | | |
| VMT Mix: | 0.622 | 0.168 | 0.077 | | 0.037 | 0.008 | 0.002 | 0.078 | 0.008 | | |
| Composite Emission Factors (Gm/Mile) | | | | | | | | | | | |
| Non-Meth HC: | 3.18 | 4.43 | 5.57 | 4.79 | 11.41 | 0.84 | 1.19 | 3.30 | 5.03 | 3.886 | |

| Cal. Year: 1991 | I/M Program: Yes | | | Ambient Temp: 88.0 (F) | | | Region: Low | | | | |
|--------------------------------------|-----------------------|-------|-------|------------------------------------|-------|-------|--------------------|-------|-------|---------|--|
| | Anti-tam. Program: No | | | Operating Mode: 20.6 / 27.3 / 20.6 | | | Altitude: 500. Ft. | | | | |
| Veh. Type: | LDGV | LDGT1 | LDGT2 | LDGT | HDGV | LDDV | LDDT | HDDV | MC | All Veh | |
| Veh. Speeds: | 20.0 | 20.0 | 20.0 | | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | | |
| VMT Mix: | 0.622 | 0.168 | 0.077 | | 0.037 | 0.008 | 0.002 | 0.078 | 0.008 | | |
| Composite Emission Factors (Gm/Mile) | | | | | | | | | | | |
| Non-Meth HC: | 2.61 | 3.60 | 4.56 | 3.90 | 9.13 | 0.69 | 0.97 | 2.71 | 4.54 | 3.178 | |

| Cal. Year: 1991 | I/M Program: Yes | | | Ambient Temp: 88.0 (F) | | | Region: Low | | | | |
|--------------------------------------|-----------------------|-------|-------|------------------------------------|-------|-------|--------------------|-------|-------|---------|--|
| | Anti-tam. Program: No | | | Operating Mode: 20.6 / 27.3 / 20.6 | | | Altitude: 500. Ft. | | | | |
| Veh. Type: | LDGV | LDGT1 | LDGT2 | LDGT | HDGV | LDDV | LDDT | HDDV | MC | All Veh | |
| Veh. Speeds: | 25.0 | 25.0 | 25.0 | | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | | |
| VMT Mix: | 0.622 | 0.168 | 0.077 | | 0.037 | 0.008 | 0.002 | 0.078 | 0.008 | | |
| Composite Emission Factors (Gm/Mile) | | | | | | | | | | | |
| Non-Meth HC: | 2.28 | 3.04 | 3.87 | 3.30 | 7.72 | 0.58 | 0.82 | 2.27 | 4.24 | 2.734 | |

-M120 Warning:

MOBILE4.1 does not model most 1993 and later Clean Air Act requirements; Emission Factors for CY 1993 or later are affected.

| Cal. Year: 1998 | I/M Program: Yes | | | Ambient Temp: 88.0 (F) | | | Region: Low | | | | |
|--------------------------------------|-----------------------|-------|-------|------------------------------------|-------|-------|--------------------|-------|-------|---------|--|
| | Anti-tam. Program: No | | | Operating Mode: 20.6 / 27.3 / 20.6 | | | Altitude: 500. Ft. | | | | |
| Veh. Type: | LDGV | LDGT1 | LDGT2 | LDGT | HDGV | LDDV | LDDT | HDDV | MC | All Veh | |
| Veh. Speeds: | 15.0 | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | | |
| VMT Mix: | 0.595 | 0.188 | 0.080 | | 0.038 | 0.002 | 0.001 | 0.090 | 0.007 | | |
| Composite Emission Factors (Gm/Mile) | | | | | | | | | | | |
| Non-Meth HC: | 1.94 | 2.92 | 2.96 | 2.93 | 6.91 | 0.83 | 1.39 | 2.57 | 4.68 | 2.467 | |

| Cal. Year: 1998 | I/M Program: Yes | | | Ambient Temp: 88.0 (F) | | | Region: Low | | | | |
|--------------------------------------|-----------------------|-------|-------|------------------------------------|-------|-------|--------------------|-------|-------|---------|--|
| | Anti-tam. Program: No | | | Operating Mode: 20.6 / 27.3 / 20.6 | | | Altitude: 500. Ft. | | | | |
| Veh. Type: | LDGV | LDGT1 | LDGT2 | LDGT | HDGV | LDDV | LDDT | HDDV | MC | All Veh | |
| Veh. Speeds: | 20.0 | 20.0 | 20.0 | | 20.0 | 20.0 | 20.0 | 20.0 | 20.0 | | |
| VMT Mix: | 0.595 | 0.188 | 0.080 | | 0.038 | 0.002 | 0.001 | 0.090 | 0.007 | | |
| Composite Emission Factors (Gm/Mile) | | | | | | | | | | | |
| Non-Meth HC: | 1.59 | 2.34 | 2.40 | 2.35 | 5.54 | 0.68 | 1.14 | 2.11 | 4.26 | 2.007 | |

| Cal. Year: 1998 | I/M Program: Yes | | | Ambient Temp: 88.0 (F) | | | Region: Low | | | | |
|--------------------------------------|-----------------------|-------|-------|------------------------------------|-------|-------|--------------------|-------|-------|---------|--|
| | Anti-tam. Program: No | | | Operating Mode: 20.6 / 27.3 / 20.6 | | | Altitude: 500. Ft. | | | | |
| Veh. Type: | LDGV | LDGT1 | LDGT2 | LDGT | HDGV | LDDV | LDDT | HDDV | MC | All Veh | |
| Veh. Speeds: | 25.0 | 25.0 | 25.0 | | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | | |
| VMT Mix: | 0.595 | 0.188 | 0.080 | | 0.038 | 0.002 | 0.001 | 0.090 | 0.007 | | |
| Composite Emission Factors (Gm/Mile) | | | | | | | | | | | |
| Non-Meth HC: | 1.34 | 1.90 | 1.97 | 1.92 | 4.71 | 0.57 | 0.96 | 1.77 | 3.99 | 1.678 | |

| Cal. Year: 2005 | I/M Program: Yes | | | Ambient Temp: 88.0 (F) | | | Region: Low | | | | |
|--------------------------------------|-----------------------|-------|-------|------------------------------------|-------|-------|--------------------|-------|-------|---------|--|
| | Anti-tam. Program: No | | | Operating Mode: 20.6 / 27.3 / 20.6 | | | Altitude: 500. Ft. | | | | |
| Veh. Type: | LDGV | LDGT1 | LDGT2 | LDGT | HDGV | LDDV | LDDT | HDDV | MC | All Veh | |
| Veh. Speeds: | 15.0 | 15.0 | 15.0 | | 15.0 | 15.0 | 15.0 | 15.0 | 15.0 | | |
| VMT Mix: | 0.575 | 0.198 | 0.081 | | 0.036 | 0.002 | 0.002 | 0.100 | 0.006 | | |
| Composite Emission Factors (Gm/Mile) | | | | | | | | | | | |
| Non-Meth HC: | 1.73 | 2.27 | 2.45 | 2.32 | 5.83 | 0.59 | 0.77 | 2.45 | 4.66 | 2.132 | |

| | | | |
|--------------------------------------|-----------------------|------------------------------------|--------------------|
| Cal. Year: 2005 | I/M Program: Yes | Ambient Temp: 88.0 (F) | Region: Low |
| | Anti-tam. Program: No | Operating Mode: 20.6 / 27.3 / 20.6 | Altitude: 500. Ft. |
| Veh. Type: | LDGV | LDGT1 | LDGT2 |
| | LDGT | HDGV | LDDV |
| | LDDT | HDDV | MC |
| | | | All Veh |
| Veh. Speeds: | 20.0 | 20.0 | 20.0 |
| VMT Mix: | 0.575 | 0.198 | 0.081 |
| Composite Emission Factors (Gm/Mile) | | | |
| Non-Meth HC: | 1.43 | 1.83 | 1.98 |
| | | 1.87 | 4.69 |
| | | 0.49 | 0.63 |
| | | 2.01 | 4.24 |
| | | | 1.743 |

| | | | |
|--------------------------------------|-----------------------|------------------------------------|--------------------|
| Cal. Year: 2005 | I/M Program: Yes | Ambient Temp: 88.0 (F) | Region: Low |
| | Anti-tam. Program: No | Operating Mode: 20.6 / 27.3 / 20.6 | Altitude: 500. Ft. |
| Veh. Type: | LDGV | LDGT1 | LDGT2 |
| | LDGT | HDGV | LDDV |
| | LDDT | HDDV | MC |
| | | | All Veh |
| Veh. Speeds: | 25.0 | 25.0 | 25.0 |
| VMT Mix: | 0.575 | 0.198 | 0.081 |
| Composite Emission Factors (Gm/Mile) | | | |
| Non-Meth HC: | 1.20 | 1.48 | 1.61 |
| | | 1.52 | 4.00 |
| | | 0.41 | 0.53 |
| | | 1.69 | 3.98 |
| | | | 1.452 |

APPENDIX F
PEDESTRIAN LEVEL WIND ASSESSMENTS

APPENDIX F1

BUILDING A OF THE BIOMEDICAL RESEARCH CENTER

98V 91-2211

**An Assessment of Pedestrian Level Winds for the Proposed
Building A of the Biomedical Research Center in
the Charlestown Navy Yard, Boston, Massachusetts**

August 20, 1991

By:

Frank H. Durgin, P.E.

Prepared for:

Boston Redevelopment Authority

**An Assessment of Pedestrian Level Winds for the Proposed
Building A of The Biomedical Research Center in
The Charlestown Navy Yard, Boston, Massachusetts**

Frank H. Durgin, P.E.

1. INTRODUCTION

1.1 Basis

This evaluation of pedestrian level winds was performed at the request of Mr. Jonathan Warner of Sasaki Associates, Inc. It is based on:

- 1) The drawings listed below received from Jonathan Warner:
 - a) Charlestown Navy Yard Master Plan dated June 1991;
 - b) A similar drawing (unnamed and no date) with isometrics of buildings at an interim stage;
 - c) Three drawings, containing N, E, S, and W elevations and transverse and longitudinal sections of the new New England Aquarium, dated Nov. 1989;
 - d) The Boston Navy Yard - Charlestown, Land Parcel Plan Alternate 2, prepared by Parsons, Brinkerhoff, Quade, & Douglas, dated Nov. 5, 1976;
 - e) City of Boston Topographic and Planimetric Map No. 19N-13E, revised 1988;
 - f) Map giving Existing Building Heights for the Charlestown Navy Yard (no date);
 - g) Elevations and Plan views for Buildings 75, 105, 106, 114, 199, 266, and for the Rowhouses on Thirteenth Street (Various dates and sources);
 - h) Section, Ground Floor Plan, and Atrium Floor Plan for Phases A, B, and C of the Biomedical Research Center dated May 21, 1991 and annotated by Don Klabin, July 10, 1991;
 - i) Two 8.5 by 11 inch drawings showing the buildings to be included in the existing and build conditions used for this study. These, with building numbers added, are included as Figures 1 and 2.
- 2) Two (2) site visits during which 28 photographs were taken of the buildings on the site and the site's surroundings;
- 3) An evaluation of the urban context of the proposed project;
- 4) A review of wind climate data for Boston; and
- 5) The author's 22 years of experience dealing with pedestrian level winds.

The interaction of the wind with buildings and structures is very complicated and, at times, unpredictable. Thus, this evaluation must be treated as a qualitative assessment of pedestrian level winds.

1.2 *Location and Description of the Project*

The site of the proposed Biomedical Research Center is at the northeast end of The Charlestown Navy Yard next to Building 114 and just across Sixteenth Street from Buildings 75 and 199. The site is currently partly occupied by Buildings 178 and 193, which will be demolished to make room for the proposed project.

Figure 1 depicts the configuration of the site that is considered to be existing conditions for this assessment. Note that the el that currently runs southwest at the north end of Building 114 is not shown since it will be removed to allow Sixteenth Street to be extended to Chelsea Street, and the currently existing Buildings 131, 165, 178, 193, 203, 206, 210, 218A, and 226, all shown in the Land Parcel Plan, Alternate 2, are assumed razed and not replaced. Buildings 77, the easterly extension of 104, 187, 214, and 215c, also shown on the Alternate 2 plan, have already been razed.

Figure 2 is identical to Figure 1 except that the position of Building A of the Biomedical Research Center is shown and the outline of the finished Center is shown by a dotted line.

Building numbers are given in both Figures. For this wind assessment it is important to know the relative heights of all the buildings. They are listed below:

| <u>Building</u> | <u>Roof Edge hgt</u>
(Feet) | <u>Total hgt</u>
(Feet) |
|-----------------|--------------------------------|----------------------------|
| P | 27 | 35 |
| 75 | 15 | 27 |
| 106 | 42 | 59 |
| 114 | 48 | 48 |
| 199 | 108 | 108 |
| 266 | 31 | 40 |
| Rowhouses | 23 | 30 |
| | 50 | 75 |
| Building A | 140 ft. | 140 ft. |

The vehicular entrance to Building A of the Biomedical Research Center is shown in Figure 2. There will be two main pedestrian entrances: one will be in the middle of the southeast end of the building; and the other in the southwest wall just north of the vehicular entrance. In the discussion that follows, the wind conditions for the configurations depicted in Figures 1 and 2 will be compared.

1.3 *Description of the Area Surrounding the Project*

This is a very exposed site. The Little Mystic Channel runs east-west just north of the site, and the Boston Inner Harbor lies to the east and south. Only to the west and southwest are there significant buildings. Most are 30-50 feet high, but there are a couple of exceptions. Building 149, about the same height as 199, lies to the southwest, just across Thirteenth Street from 199. A little more to the south and about 1400 feet away lies Building 197 at about 120 feet in height. Downtown Boston, including the Financial District with its many 25-40 story buildings, lies across the Boston Inner Harbor about 1.75 miles SSW of the site.

2. THE WIND CLIMATE

2.1 *Variation of Average Velocity with Height*

In general, the natural wind is unsteady (i.e., it is gusty), and its average velocity increases with height above the ground. Figure 3 depicts approximately how the average velocity varies with height for different types of terrains. When one puts up any building, the possibility exists (although generally it does not happen) that the building will bring the higher speed winds at the top of the building down to ground level.

Monolithic buildings (i.e., those that do not change shape with height), if they are significantly taller than most of the surrounding buildings, almost invariably will be windy at their base. However, when there are many buildings of similar height in an area, the buildings tend to shelter one another.

The proposed Building A of the Biomedical Research Center is very exposed to NE, E, and SE winds, and it seems likely that NE and E winds will cause accelerated winds at the pedestrian entrance in the SE wall.

2.2 *Statistical Description of Wind*

The site is about 1.75 miles from Downtown Boston and about 2.25 miles west of Logan Airport. Thus, the wind data from Logan Airport, which is typically used to define winds for Boston, is applicable. Figure 4 depicts a wind rose for Boston. As noted in the figure, the wind rose is based on surface wind data from Logan Airport taken from 1945 to 1965. The length of each line radiating from the center of the figure to the outermost crossing line is proportional to the total time the wind comes from that direction. The other lines crossing the radial lines are for winds less than 3, 12, and 25 mph.

Figure 4 shows that the winds in Boston come primarily from the northwest, west, and southwest. Figures 5-8 show wind roses for Boston for winter (Dec., Jan., and Feb.), spring (Mar., Apr., and May), summer (Jun., Jul., and Aug.), and Fall (Sep., Oct., and Nov.). These figures show that northwest winds tend to occur in the winter, and southwest winds in the summer. Spring and fall are transitional, but winds are stronger in the spring than in the fall. Strong easterly winds usually occur during storms when there is precipitation. Northwest winds blow across the Mystic Tobin Bridge and straight down Thirteenth and Sixteenth Streets. Southwest winds blow up First, Third, and Fifth Avenues.

The effect of these winds as well as easterly storm winds is discussed below separately.

The average wind speed at Logan Airport at 58 feet (the average height at which the data were taken) is 12.9 mph. At pedestrian level (i.e., chest height, 4.5 feet), it is about 8 mph. The average wind speed at 58 feet at Logan Airport for each month is shown in Figure 9. Seasonally, the average is 14.2 mph in the winter, 13.9 mph in the spring, 11.2 mph in the summer, and 12.3 mph in the fall. However, the fastest hourly wind for a 100 hour return period is slightly faster in the spring than in winter.

3. CRITERIA

Since the early 1980s, Boston has used a guideline criterion for acceptable winds of not exceeding a 31 mph effective gust more often than once in 100 hours. The effective gust is defined as the average plus 1.5 times the root mean square (rms) variation about the average.

In 1978, Melbourne developed probabilistic criteria for pedestrian level winds which account for different types of pedestrian activity as well as safety aspects of such winds (see Figure 10). He defined five categories for pedestrian level winds:

- 1) Unacceptable and Dangerous.
- 2) Uncomfortable for Walking.
- 3) Acceptable for Walking.
- 4) Acceptable for Short Periods of Standing or Sitting.
- 5) Acceptable for Long Periods of Standing or Sitting.

These criteria are not absolute (any location can have dangerous winds in a hurricane), but rather they imply that the location would have wind speeds such that the activity suggested is possible most of the time, and would be perceived as such by most people who are at the location frequently. For example, winds at pedestrian level at Logan Airport are just in Category 2, uncomfortable for walking, and just under the guideline 31 mph effective gust wind speed.

4 PEDESTRIAN WINDS AT THE SITE

4.1 *Introduction*

In the following sections, the effects of the northwest (NW) winter winds, the southwest (SW) summer winds, and easterly storm winds will be discussed for the Existing and Build conditions defined in Figures 1 and 2.

For the most part, the weather in New England is dominated by either large coastal storms (fall, winter, and spring) or the Bermuda High (summer). Typically, when a coastal storm occurs, it rains or snows for four to twelve hours, then it clears, and the wind blows from the northwest for three or four days before the next weather system arrives. These storms, and the northwest winds following them, occur mostly in the fall, winter, and spring. Northwest winds are particularly uncomfortable in the winter, when typically they occur on cold days. The Bermuda High is responsible for the southwest winds that occur in the summer.

4.2 *Northwest (Winter) Winds (Figures 11 and 12)*

As previously noted, northwest winds blow across the Mystic Tobin Bridge and directly down Thirteenth and Sixteenth Streets. They can be very uncomfortable on a cold winter day.

4.2.1 *Existing Conditions (Figure 11)*

The removal of the el on Building 114 to allow Sixteenth Street to be extended to intersect Chelsea Street opens Sixteenth Street up to the NW winds coming under the Mystic Tobin Bridge. The removal of Building 217 opens the gap further, so that it is to be expected that there will be significant acceleration of these winds in Sixteenth Street between Buildings 199 and 114. Normally, that area would be windy now, since Building 199 is twice as tall as the upwind buildings, and one would expect the higher winds to be brought down from the top of Building 199. But the Mystic Tobin Bridge is about the same height as Building 199 in that area and probably significantly reduces the NW winds coming at the upper stories of Building 199. As a result, it seems likely that winds at both the north and west corners of Building 199 are accelerated, but not as much as without the Mystic Tobin Bridge. It seems likely that the winds at the north corner of Building 199 will be in mid or high Melbourne Category 3, and those at the west end in mid or low Category 3.

The only other place where one might expect accelerated NW winds in the area under consideration for the existing conditions shown in Figure 11 is near and under the pedestrian overpasses at the corner of Thirteenth Street and Third Avenue. The main pedestrian entrances to both Buildings 199 and 149 are under these overpasses. Normally, one would expect the winds there to be high in Category 3 or low in Category 2. But with the Mystic Tobin Bridge upstream, they are probably no worse than high Category 3.

The winds at the Harborwalk along the Little Mystic Channel and Boston Inner Harbor will probably be high in Melbourne Category 3 due to its very exposed nature (its exposure is similar to that at Logan Airport). Toward the Harborwalk's southern end, particularly near the Rowhouses, it will be less windy, since much of Harborwalk in that area is in the lee of some of the buildings.

Most other places in the area under consideration will be in Melbourne's Categories 4 or 5, and it seems unlikely that the guideline effective gust wind speed will be exceeded anywhere in the area of consideration for NW winds.

4.2.2 *With Building A in Place (Figure 12)*

The addition of Building A to the site will have little or no effect on the winds at the SW end of Building 199 or on the Harborwalk, except in the lee of Building A where the winds will be reduced. It will cause an increase in the winds along Sixteenth Street between Building 199 and Building A for NW winds. However, the effect will be much less than one would normally expect, because the narrow street between Buildings 114 and A will cause the high winds at the west corner of Building A to be near the roof level of Building 114 instead of at ground level.

In any case, the entrance to Building A to the north of the vehicle entrance will probably be in Melbourne's Category 3 for NW winds, but the entrance in the middle of the southeast (SE) facade will be in the lee of the building and probably in Category 5.

4.3 *Southwest (Summer) Winds (Figures 13 and 14)*

The prevailing winds in the summer are from the southwest. Southwest winds approach the site coming directly up First and Fourth Avenues from the west end of the Yard. It should be borne in mind that, on hot summer days, some windiness may be desirable.

4.3.1 *Existing Conditions (Figure 13)*

For SW winds, with the exception of Buildings 149 and 197, all upwind buildings are 2 to 5 stories and act to shield the buildings of similar height on the site (P, 75, 106, 266, and the Rowhouses). Building 149 is the same height as Building 199, and is just across Thirteenth Street and slightly displaced to the south. As such, it provides considerable shielding for Building 199. Thus, the south corner of Building 199 is probably never windy for SW winds, and the west corner only somewhat windy for the more westerly of these SW winds (Melbourne 3 at most).

Most of the Harborwalk at Yard's End is always in the lee of Navy Yard buildings for SW winds and, thus, will be quite pleasant in the summer (probably in Melbourne 4 or 5). However, where the Harborwalk passes the small tower at the SE end of the Rowhouses, there may be some windiness (Melbourne 3).

For SW winds, the corner of Fifth Avenue and Sixteenth Street may be somewhat windy due to Building 114 deflecting the wind SE down Sixteenth Street (Melbourne 3 or 4).

Finally, because the tower at the NW end of the Rowhouses is considerably taller than any of the buildings upwind of it, for SW winds its west corner may be a little windy (Melbourne 3).

All areas not specifically mentioned are expected to be in Melbourne Category 4 or 5.

4.3.2 *With Building A in Place (Figure 14)*

Placing Building A on the site will have little or no effect on the winds near the Rowhouses or at the west end of Building 199. Normally, one would expect it to reverse the SE winds in Sixteenth Street, but with both Buildings 199 and 149, which are of similar height and upstream of Building A, those winds will be reduced, but not reversed. Also, the expected accelerated winds near the pedestrian entrance in the SE wall will be much reduced for the same reason (certainly no worse than Melbourne 3).

Finally, Building A will provide sheltering for the portion of Harborwalk that lies to the northeast (NE) of it. All areas not specifically mentioned are expected to be in Melbourne Category 4 or 5.

4.4 *Storm (Easterly) Winds (Figures 15 and 16)*

Easterly winds occur about one third of the time. Light easterly winds occur as a storm first starts or in the summer as a sea breeze. During the first 4-12 hours of a typical coastal storm, it rains or snows depending on the temperature, and the wind is generally from the northeast or southeast depending on whether the center of the storm passes to the east or west of the city.

Since, for strong easterly winds, it will generally be snowing or raining, the emphasis in the following discussions will be on entering or exiting the various buildings.

4.4.1 *Existing Conditions (Figure 15)*

The entire area under consideration is very exposed to easterly winds, and that is especially true for the Harborwalk. However, since pedestrians will not be out to enjoy a pleasant walk during storms, this is not a problem. Most people out in a storm expect it to be windy, and for light winds there is no problem.

Again, the Harborwalk near the tower at the south end of the Rowhouses will have accelerated winds at such times.

For NE winds, the east corner of Building 114 may be windy, but there is no sidewalk or entrance near the east corner.

NE winds also will make the north and east corners of Building 199 windy, the east corner perhaps more than the north, because the north corner is somewhat shielded by Building 114. There is neither an entrance near each corner, nor is there a walkway to another area, so there is no need for pedestrians to be in the vicinity. However, because of the presence of Building 149, the main entrances to Buildings 149 and 199 under the pedestrian overpasses above Thirteenth Street are likely to be windy in NE storms.

East and southeast winds cause similar problems, and since the main entrance to Building 199 is on the SW wall near its south corner, such winds probably currently make that entrance and the entrance to Building 149 windy, but no more than high Melbourne 3.

The north and east corners of the small tower at the NW end of the Rowhouses will also be windy.

The shapes of Buildings 75 and 106 are such that they will not cause significantly accelerated winds near their north and east corners.

4.4.2 *With Building A in Place (Figure 16)*

When Building A is in place, it will shield the north and east corners of Building 199, reducing the winds there.

For NE and E winds, the pedestrian entrance to Building A just north of the vehicular entrance on Sixteenth Street will be shielded from the wind. On the other hand, the entrance at the southeast end of the building will see highly accelerated flow (Melbourne 2). This will not be true when the rest of the Biomedical Center is completed, since then it will be shielded by the other buildings in the complex. This could prove a serious problem, but could be solved by use of an appropriate temporary wind break as sketched in Figure 2.

For NE winds, Building A will shield Buildings 199 and 149 and, thus, reduce any current windiness at their main entrances, but for east and SE winds, the windiness there could become slightly worse. Again, building the rest of the Biomedical Research Center will help for east winds. The completion of the new New England Aquarium will probably help for SE winds. Trees and wind breaks may be necessary to mitigate these winds until these other buildings are completed.

5. SUMMARY

An assessment of the effect of adding Building A of the proposed Biomedical Research Center to the Charlestown Navy Yard complex has been made. The assessment assumes all buildings scheduled to be demolished are demolished for the existing conditions. While, for both NW winter and SW summer winds, there are some minor increases in winds near Building A when it is added, no seriously windy areas will be caused by the addition of Building A.

On the other hand, easterly storm winds will cause much windiness at the main entrance of Building A and possibly increase the current windiness at the existing main entrances to Buildings 149 and 199. Both these windy areas will be mitigated by the completion of the rest of the Biomedical Research Center and the New England Aquarium. Temporary wind breaks such as trees and shrubs or a slotted wall could be used near the main entrance to Building A (see Figure 2) until these other planned buildings are completed.

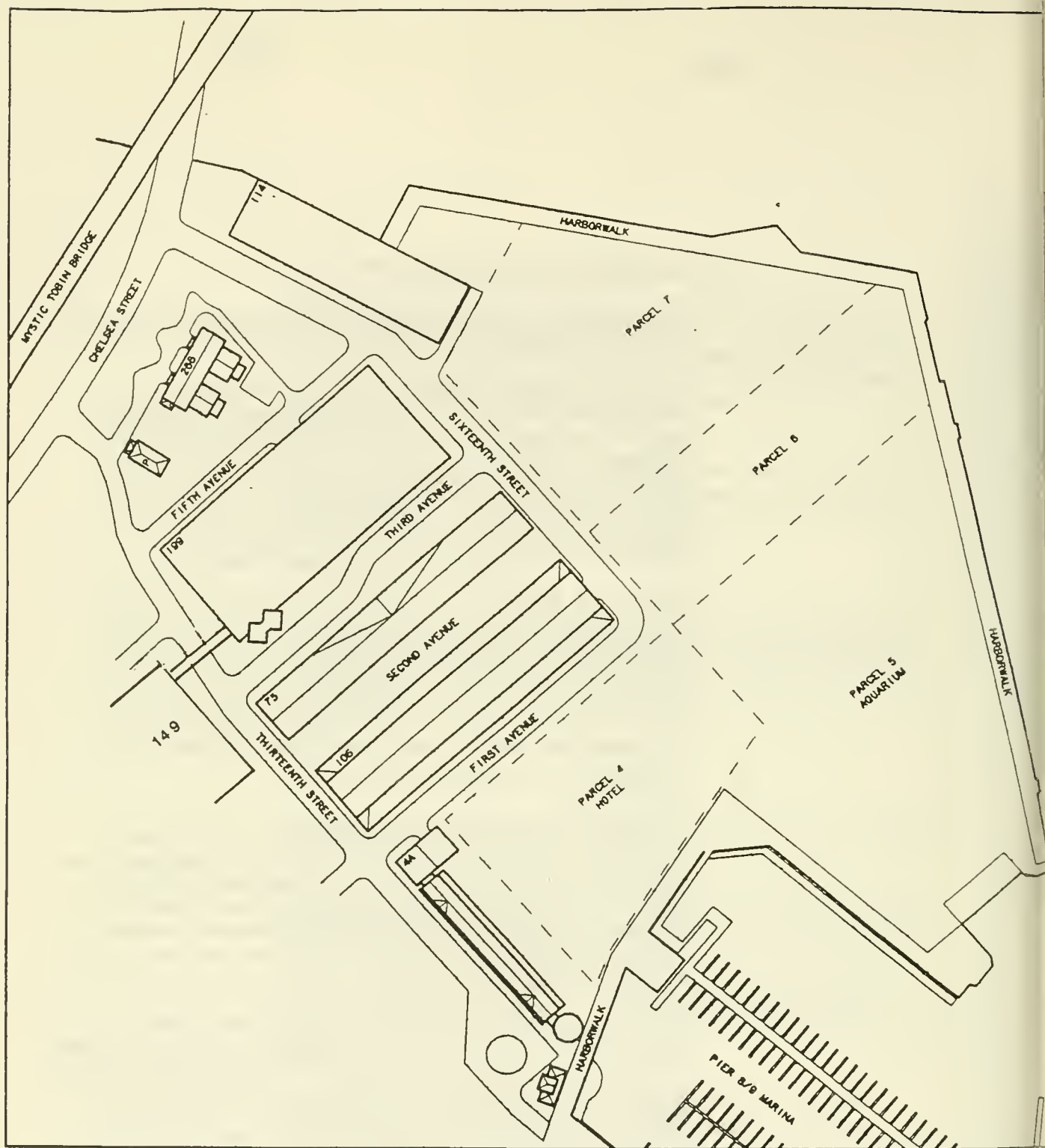
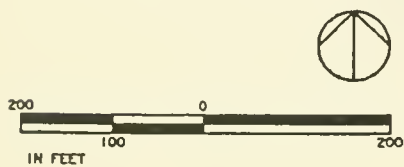


Figure 1 Existing Conditions



Charlestown Navy Yard
Biomedical Research Center
Building A, Wind Assessment
Prepared By: Frank H. Durgin, P.E.

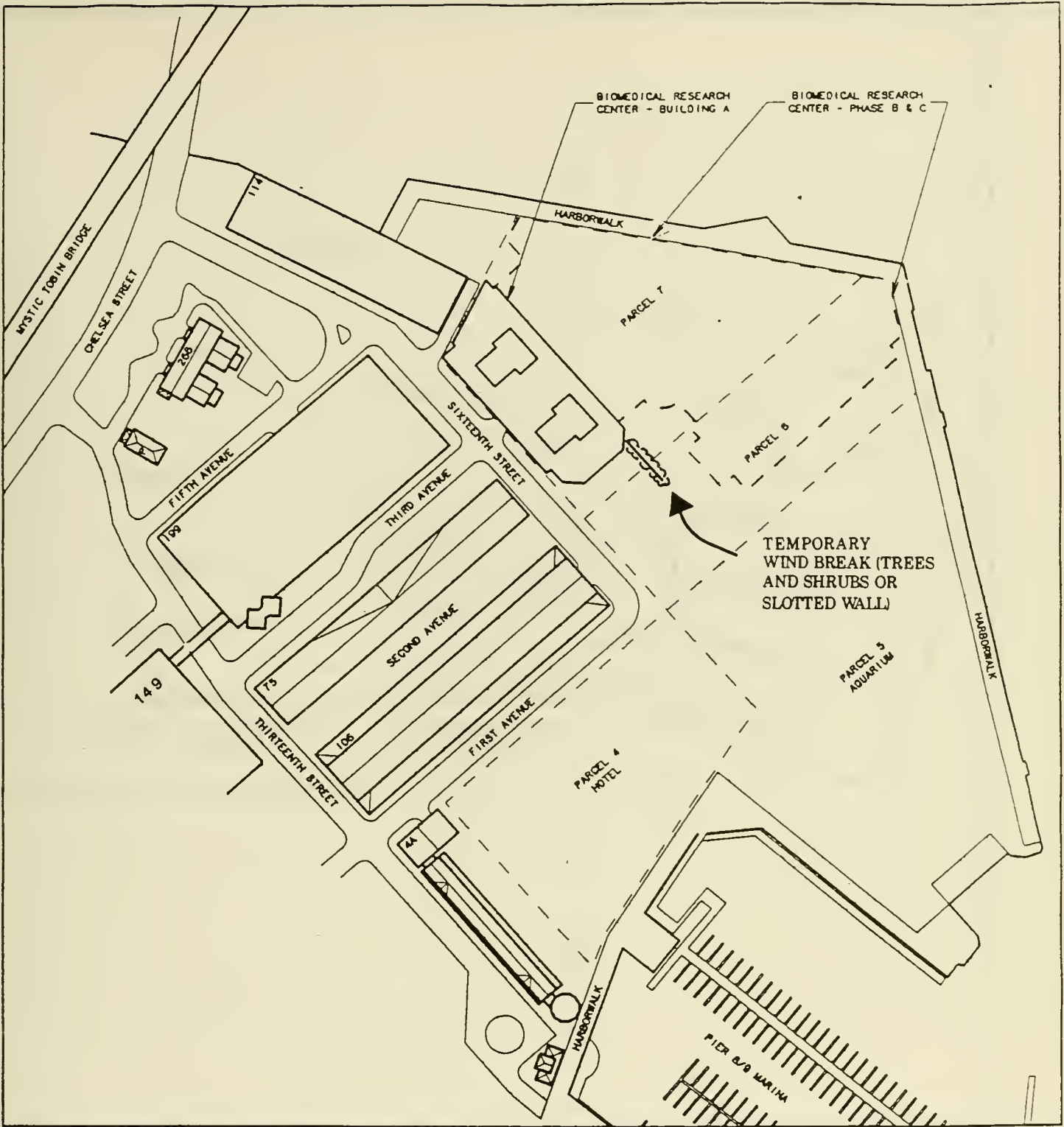
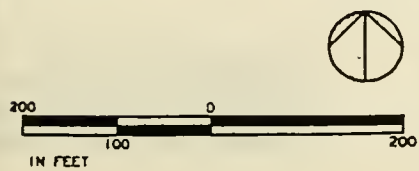


Figure 2 Proposed Conditions



Charlestown Navy Yard
Biomedical Research Center
Building A, Wind Assessment
Prepared By: Frank H. Durgin, P.E.

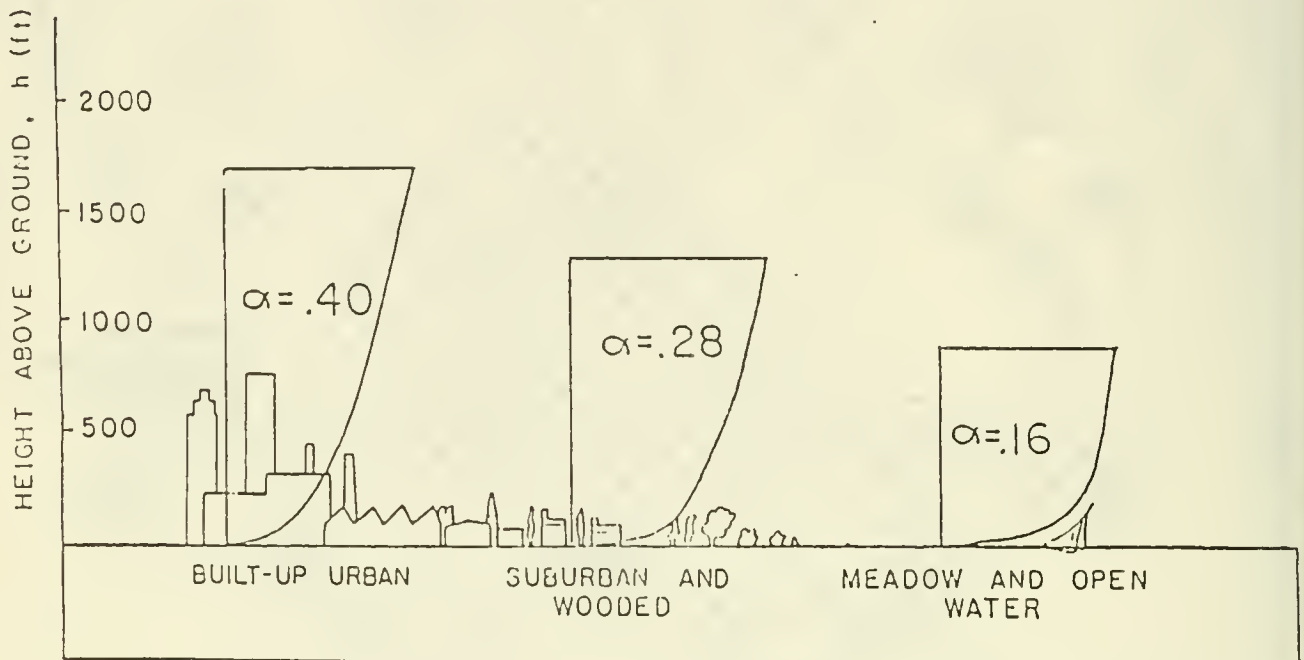


Figure 3

Types Of Earth's Boundary Layer — — Davenport

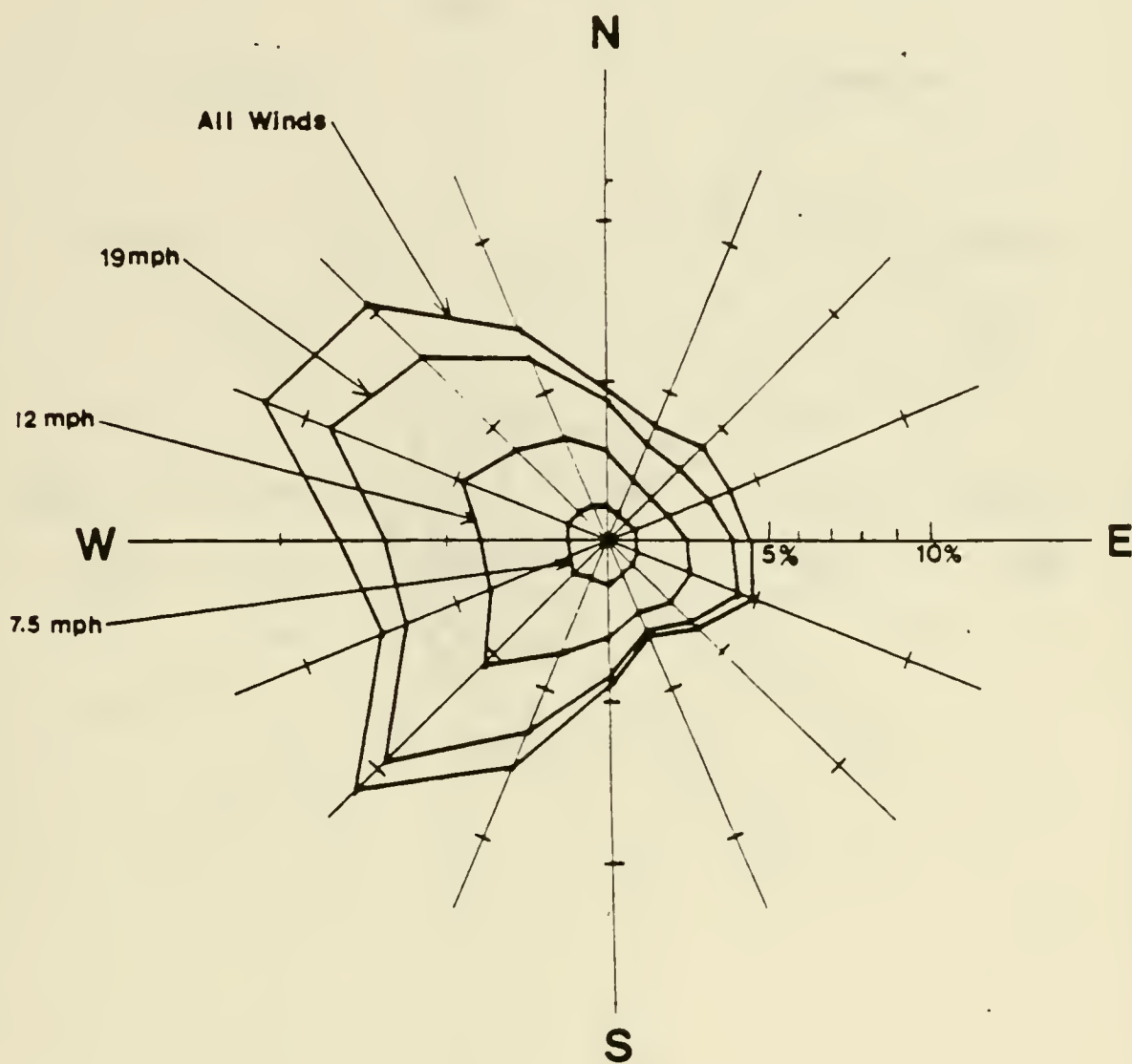


Figure 4

Boston Wind Rose For The Year

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Biomedical Research Center
Building A, Wind Assessment
Prepared By: Frank H. Durgin, P.E.

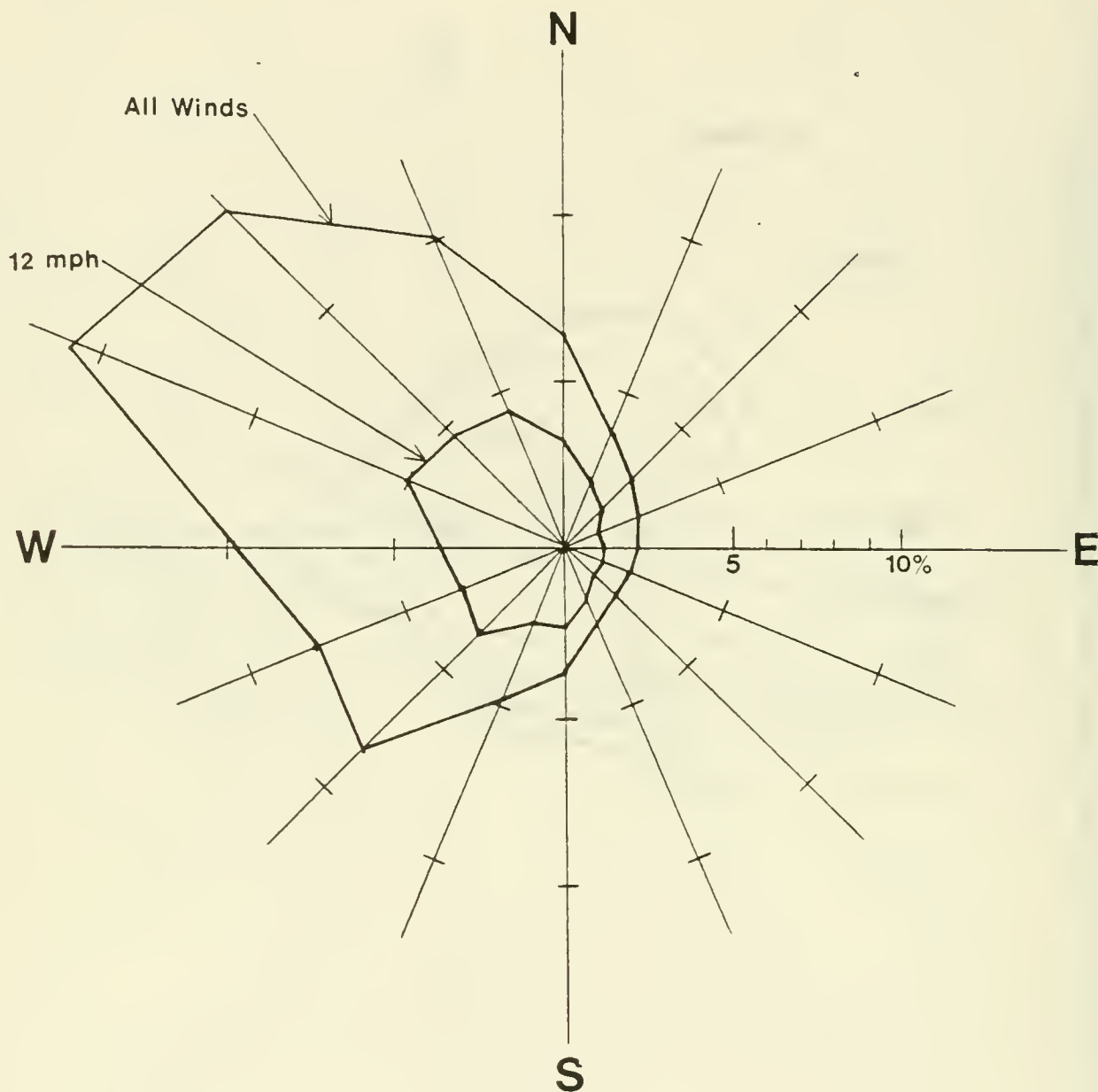


Figure 5

Boston Wind Rose For The Winter (December, January, February)

Surface Data Obtained From Logan Airport 1945-1965

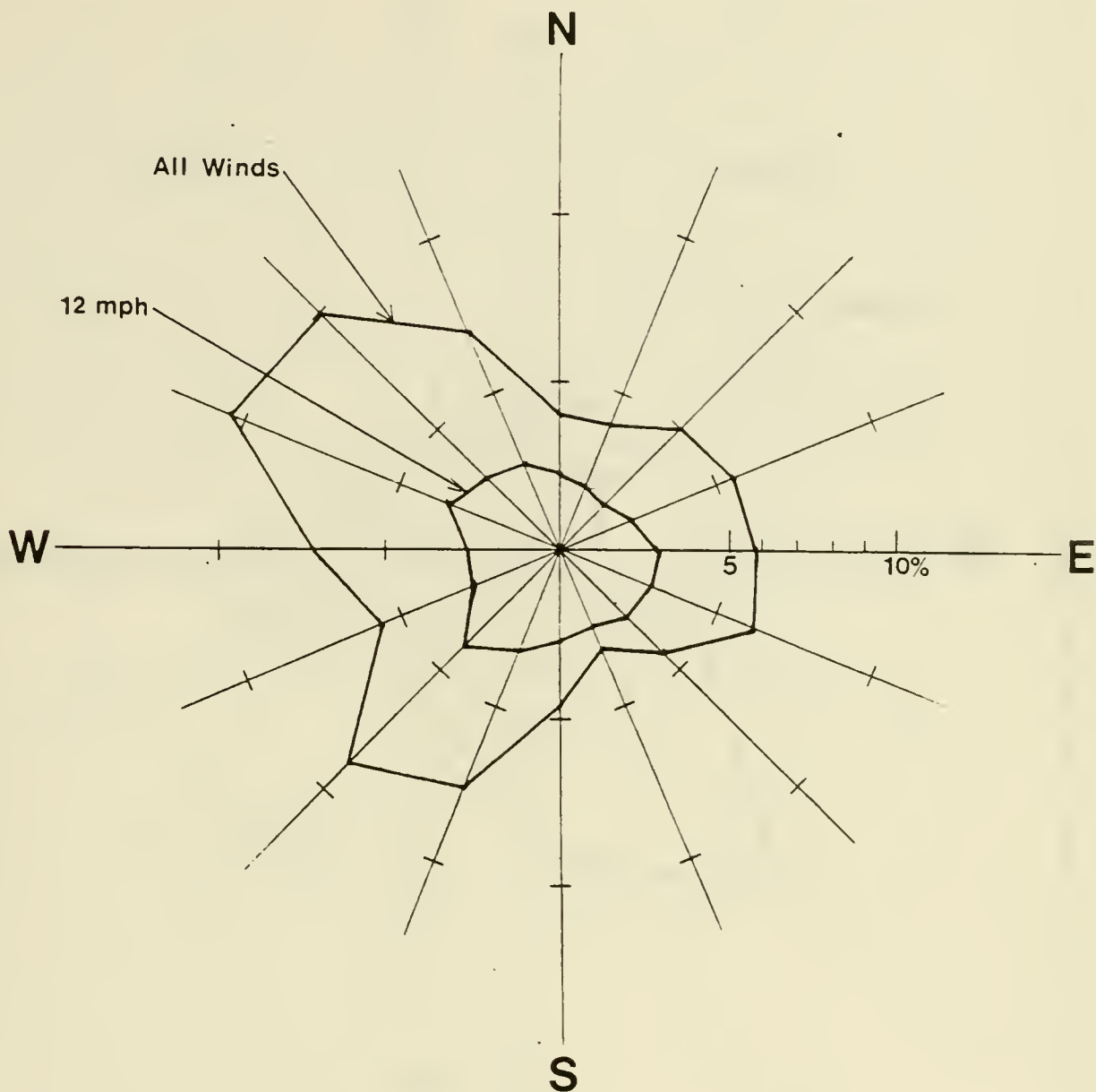


Figure 6

Boston Wind Rose For The Spring (March, April, May)

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Biomedical Research Center
Building A, Wind Assessment
Prepared By: Frank H. Durgin, P.E.

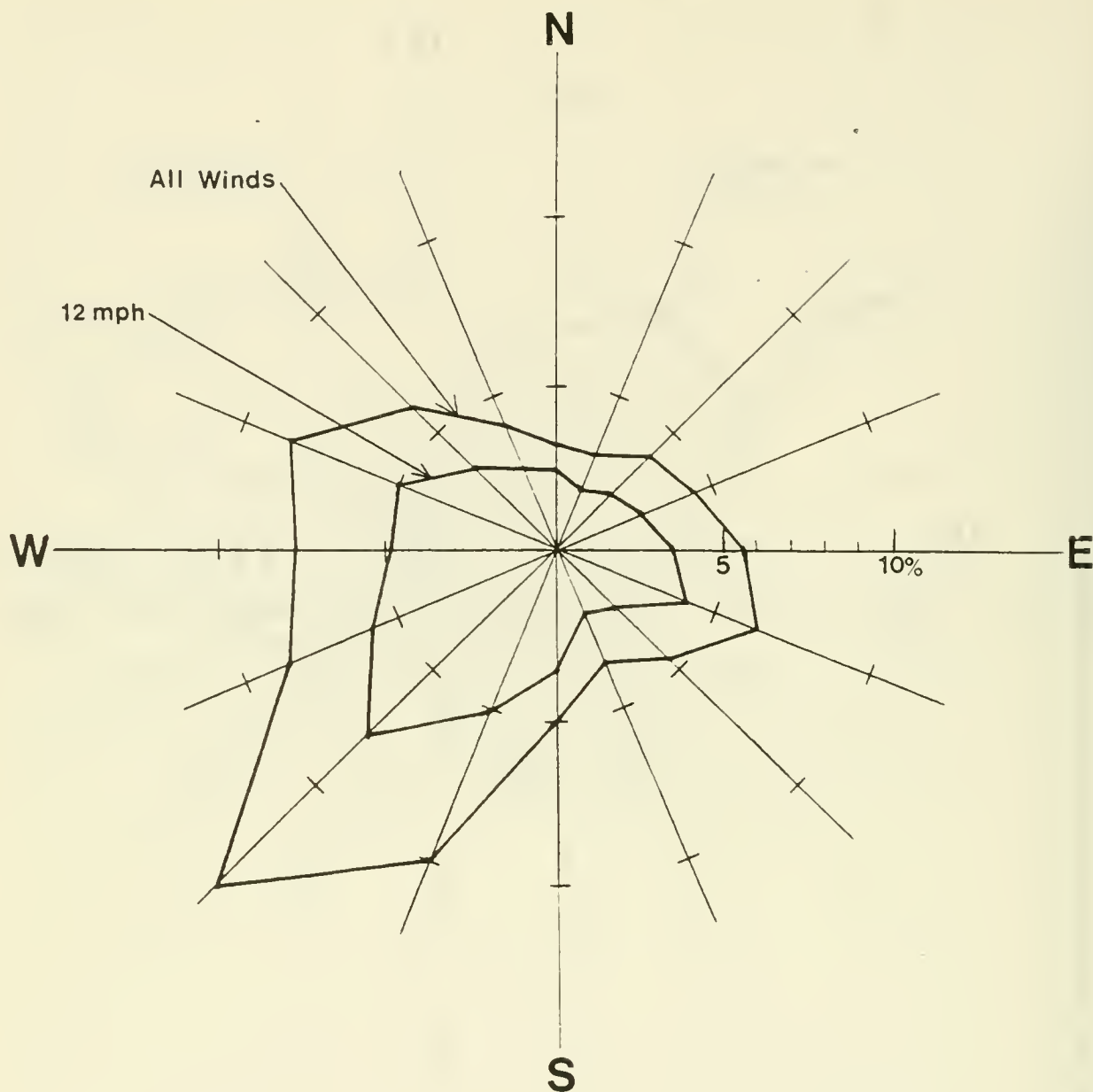


Figure 7

Boston Wind Rose For The Summer (June, July, August)

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Biomedical Research Center
Building A, Wind Assessment
Prepared By: Frank H. Durgin, P.E.

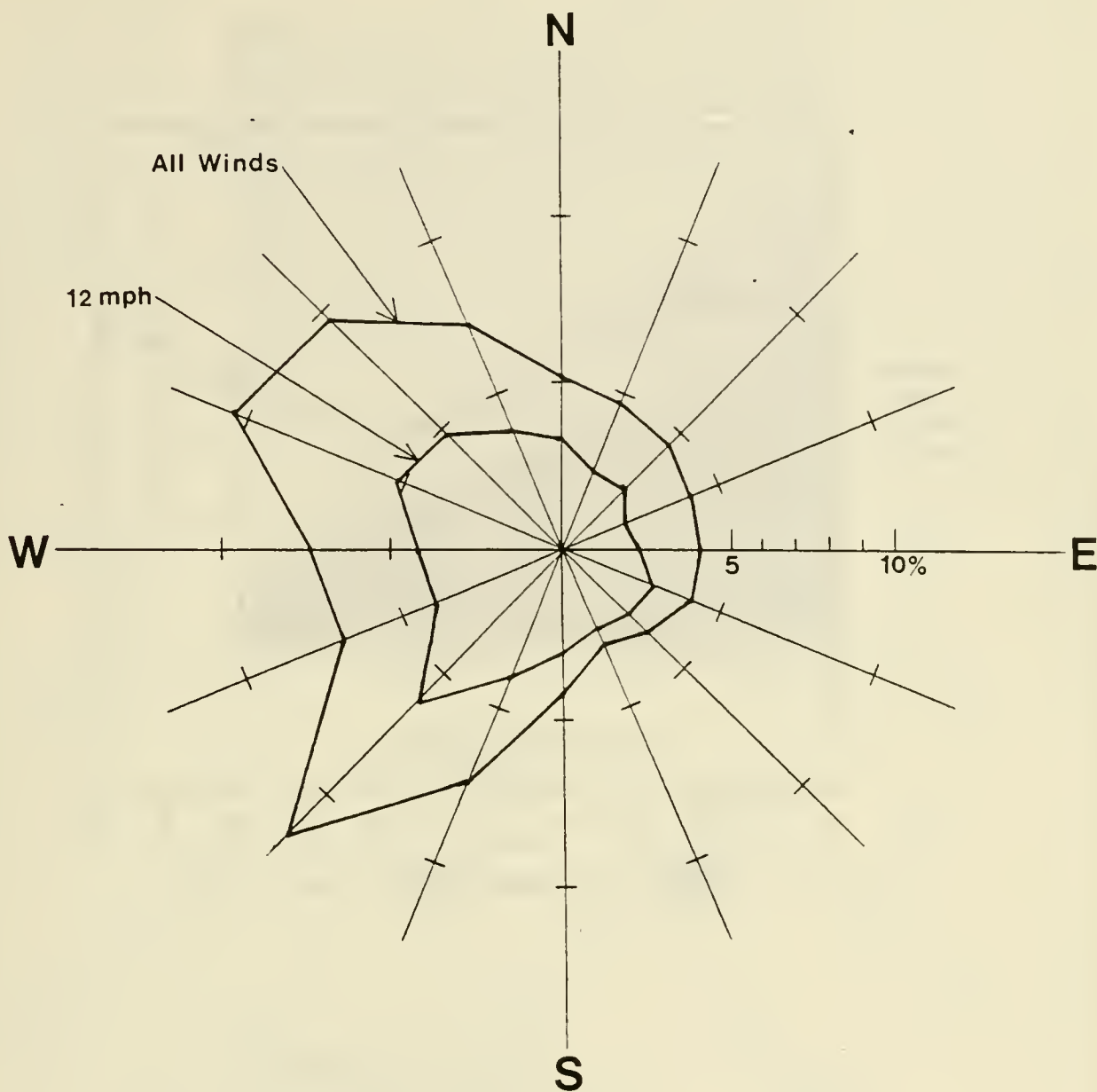


Figure 8

Boston Wind Rose For The Fall (September, October, November)

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Biomedical Research Center
Building A, Wind Assessment
Prepared By: Frank H. Durgin, P.E.

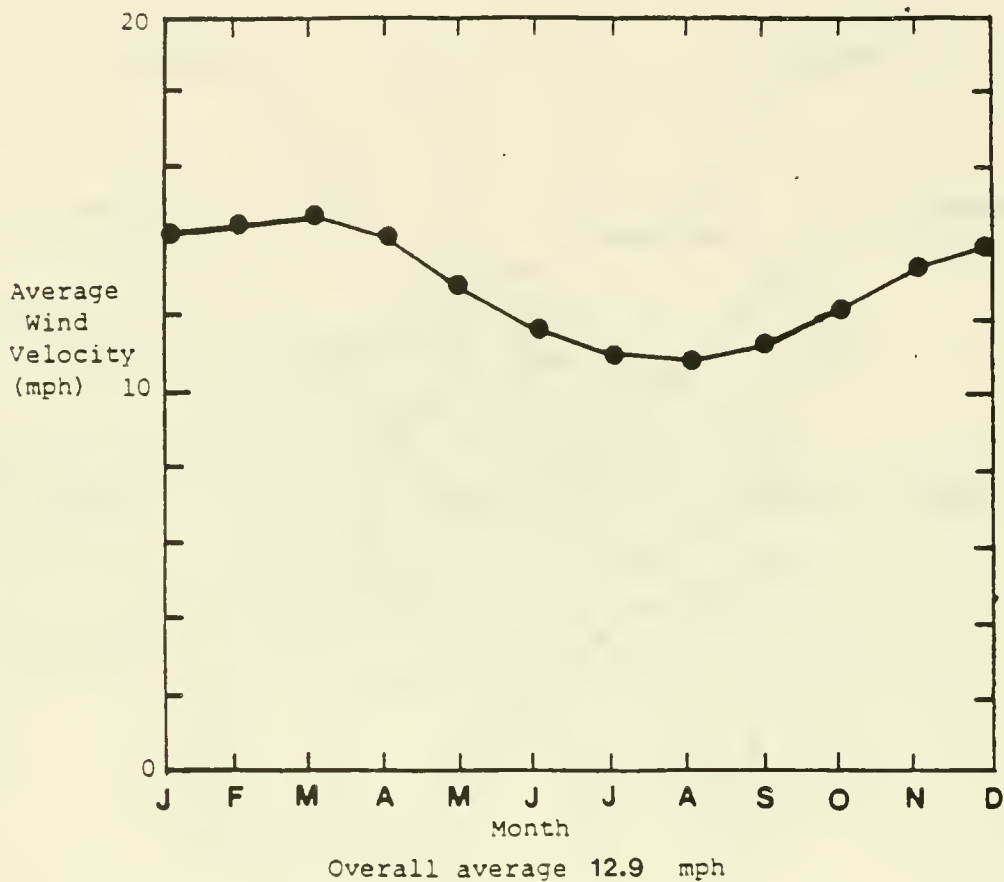
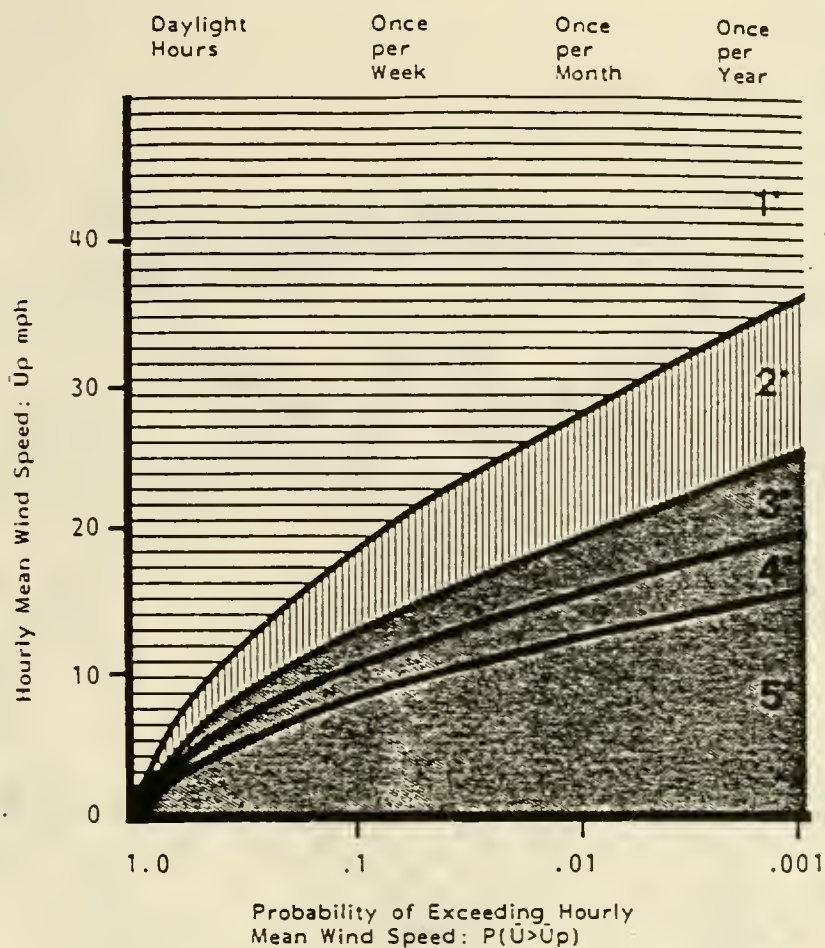


Figure 9

Average Wind Velocity At Logan Airport At 58 ft, 1945-1965, By Month



Dangerous
 Uncomfortable
 Comfortable

*Melbourne's Category

- 1 Unacceptable and dangerous
- 2 Uncomfortable for walking
- 3 Acceptable for walking
- 4 Acceptable for short periods of standing or sitting
- 5 Acceptable for long periods of standing or sitting

Figure 10

Melbourne's Category

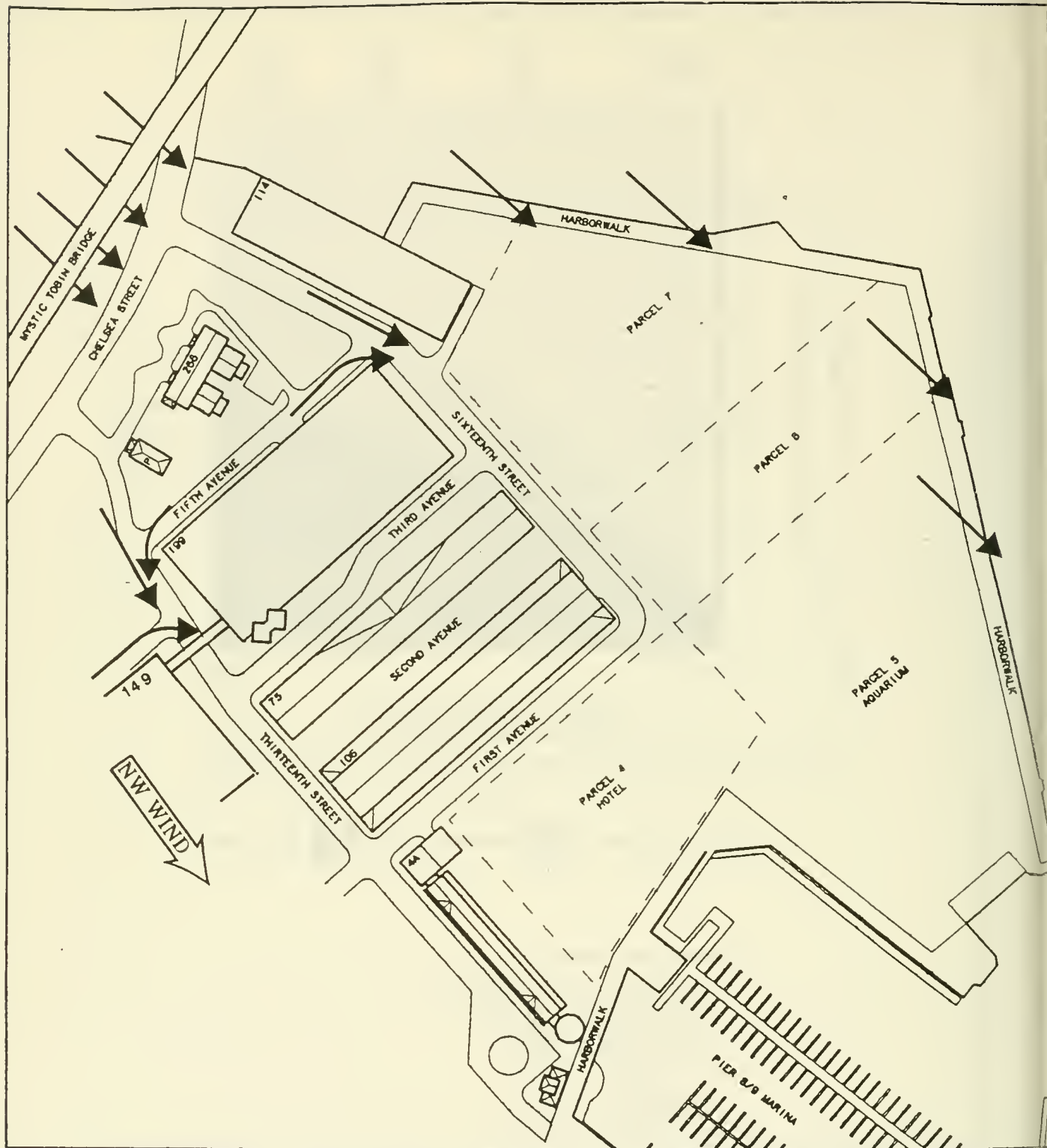
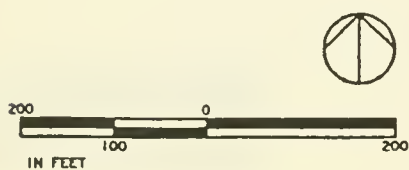


Figure 11

Existing Condition Wind Flow Patterns - Winds From Northwest



← Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Building A, Wind Assessment
Prepared By: Frank H. Durgin, P.E.

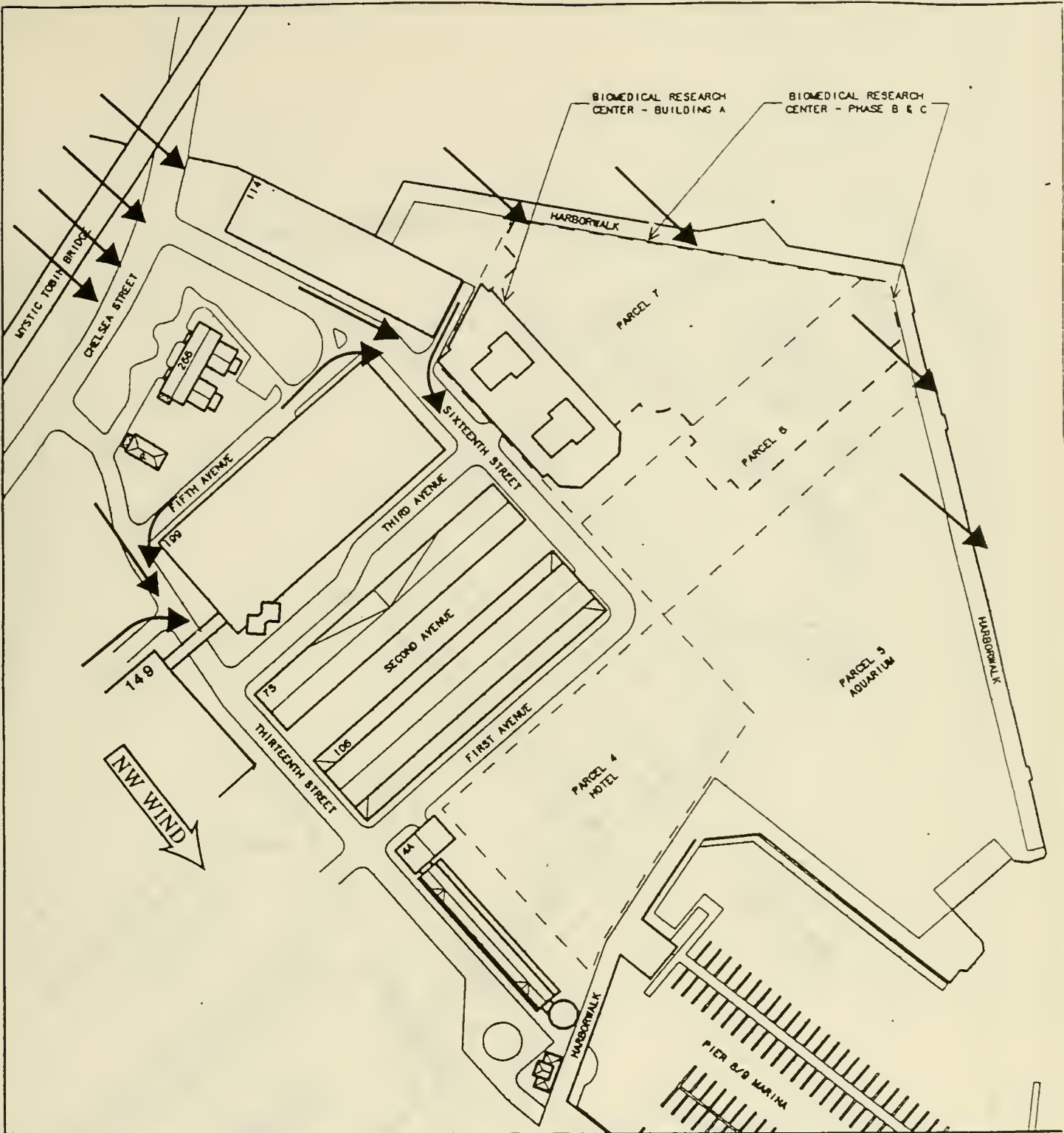


Figure 12

Proposed Condition Wind Flow Patterns - Wind From Northwest



200 0 200
IN FEET

← Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Building A, Wind Assessment
Prepared By: Frank H. Durgin, P.E.

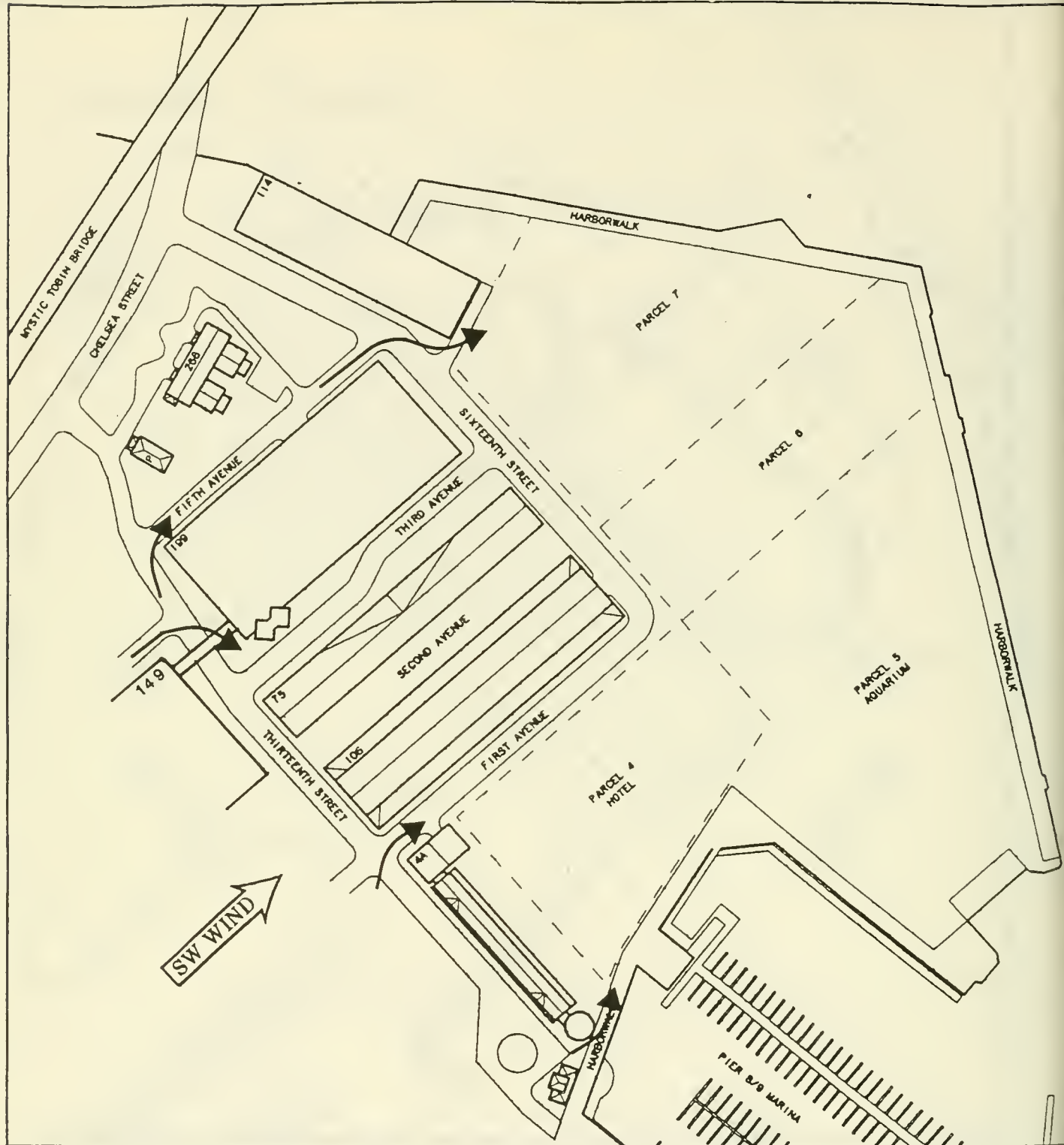
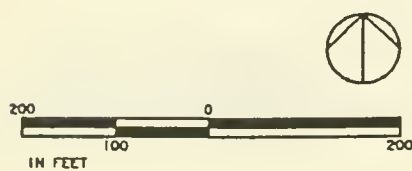


Figure 13

Existing Condition Wind Flow Patterns - Wind From Southwest



← Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Building A, Wind Assessment
Prepared By: Frank H. Durgin, P.E.

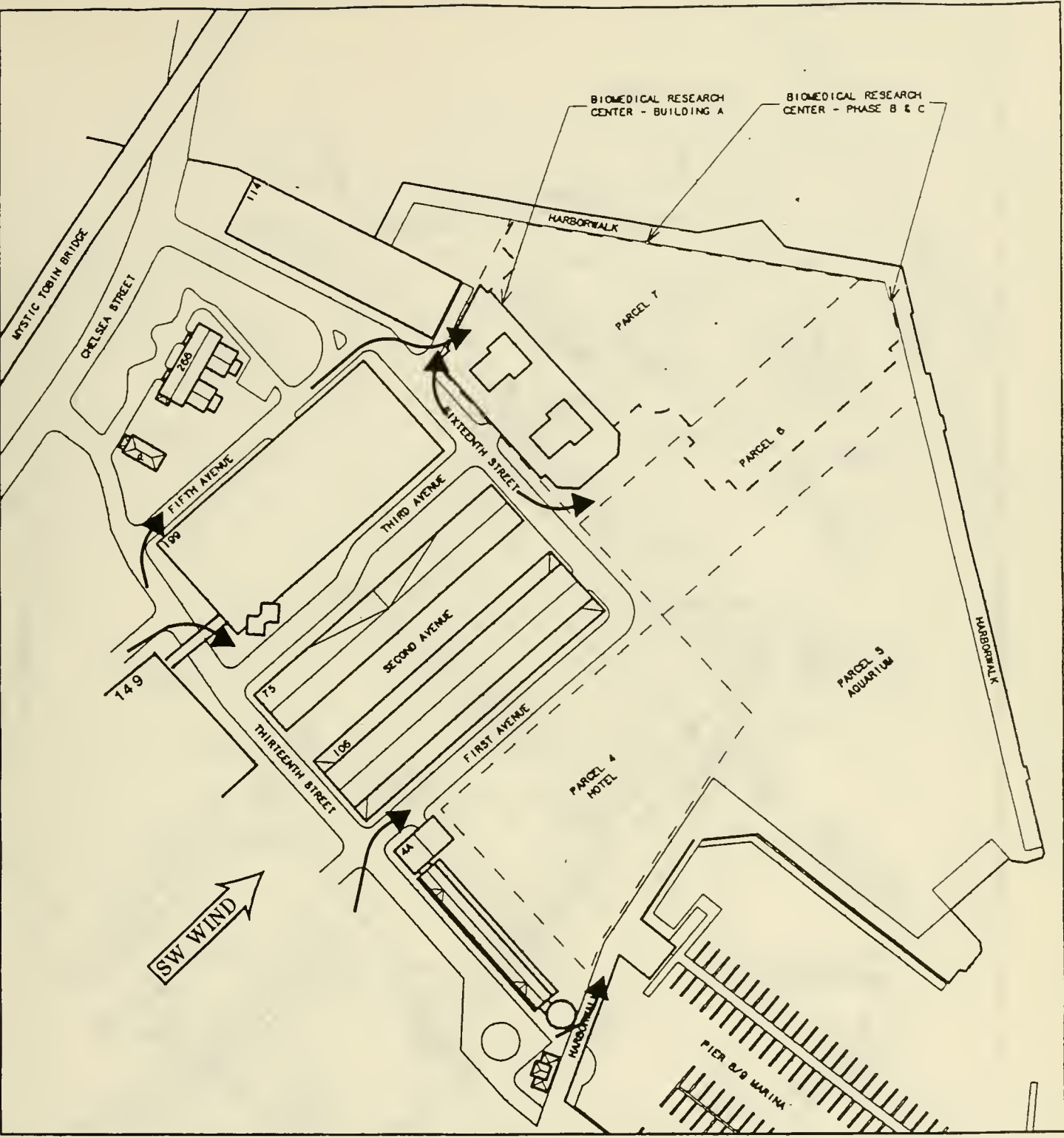


Figure 14 Proposed Condition Wind Flow Patterns - Wind From Southwest

Charlestown Navy Yard
Biomedical Research Center
Building A, Wind Assessment
Prepared By: Frank H. Durgin, P.E.

Local Wind Direction

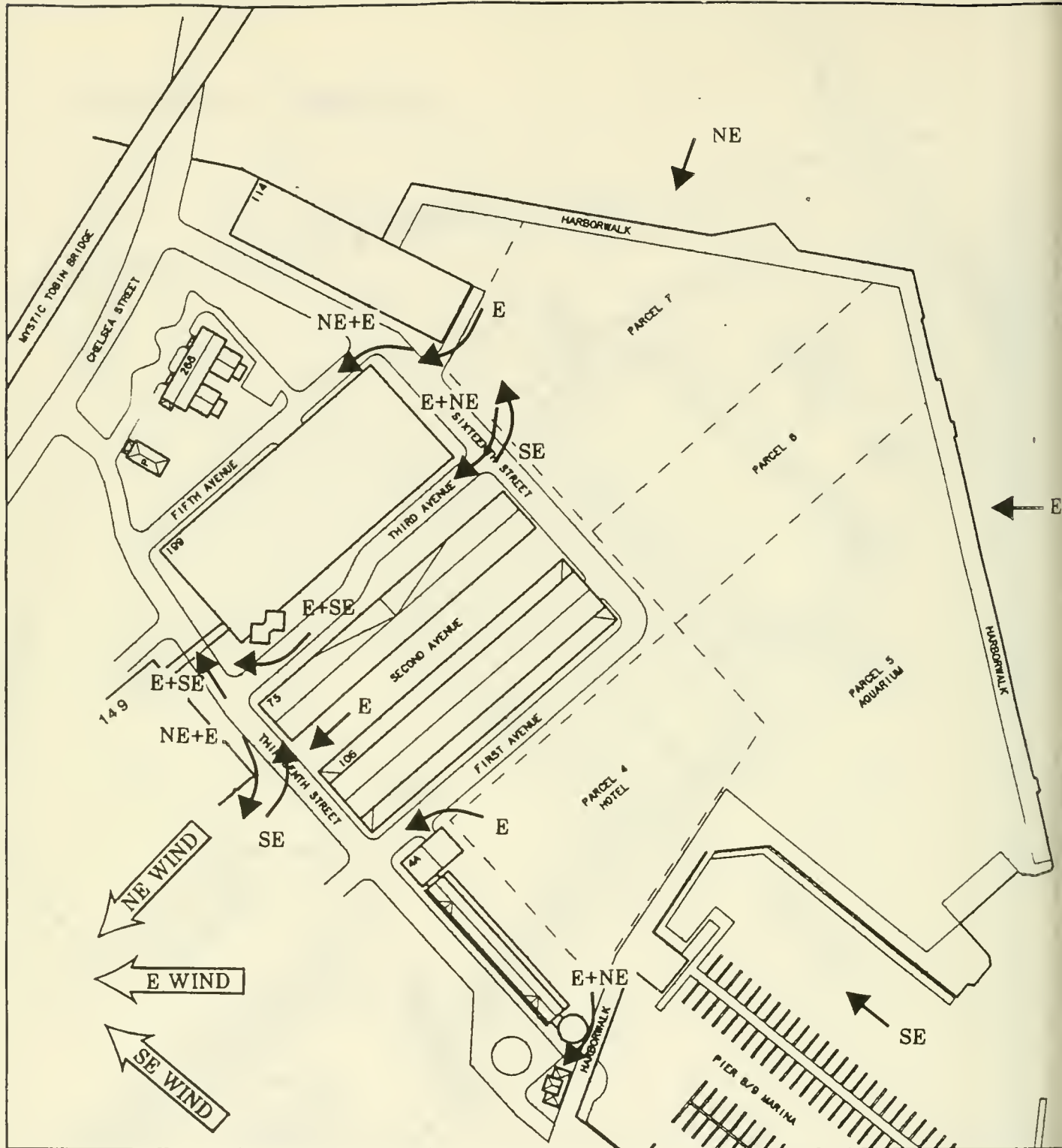
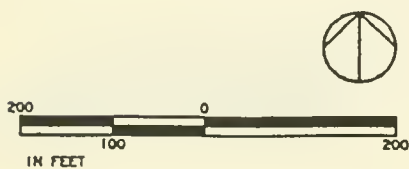


Figure 15

Existing Condition Wind Flow Patterns - Wind From Northeast, East And Southeast



Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Building A, Wind Assessment
Prepared By: Frank H. Durgin, P.E.



APPENDIX F2
PARCEL 4 HOTEL

gov 91-2278

AN ASSESSMENT OF PEDESTRIAN LEVEL WINDS
FOR THE PROPOSED PARCEL 4 HOTEL
IN THE CHARLESTOWN NAVY YARD, BOSTON, MASSACHUSETTS

AUGUST 28, 1991

BY:

FRANK H. DURGIN, P.E.

SUBMITTED TO:

SASAKI ASSOCIATES, INC.

PREPARED FOR:

BOSTON REDEVELOPMENT AUTHORITY

AN ASSESSMENT OF PEDESTRIAN LEVEL WINDS
FOR THE PROPOSED PARCEL 4 HOTEL
IN THE CHARLESTOWN NAVY YARD, BOSTON, MASSACHUSETTS

1 INTRODUCTION

1.1 BASIS

This evaluation of pedestrian level winds is based on:

1) The drawings listed below received from Jonathan Warner of Sasaki Associates:

- a) Charlestown Navy Yard Master Plan dated June 1991;
- b) A similar drawing (unnamed and no date) with isometrics of buildings at an interim stage;
- c) Three drawings containing N, E, S, and W elevations and transverse and longitudinal sections for the new New England Aquarium dated November, 1989;
- d) The Boston Navy Yard - Charlestown, Land Parcel Plan Alternate 2, prepared by Parsons, Brinkerhoff, Quade, and Douglas, dated November 5, 1976;
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- g) Elevations and Plan views for Buildings 75, 105, 106, 114, 199, 266, and for the Rowhouses on Thirteenth Street (various dates and sources);
- h) Section, Ground Floor Plan, and Atrium Floor Plan for Phases A, B, and C of the Biomedical Research Center dated May 21, 1991 and annotated by Don Klabin, July 10, 1991;
- i) Three 8.5" by 11" figures showing the entrances to all buildings of interest.

2) Two site visits during which 28 photographs were taken of the buildings on the site and in the site's surroundings;

3) An evaluation of the urban context of the proposed project;

4) A review of wind climate data for Boston; and

6) Frank Durgin's 22 years of experience dealing with pedestrian level winds.

The interaction of the wind with buildings and structures is very complicated and, at times, unpredictable. Thus, this evaluation must be treated as a qualitative assessment of pedestrian level winds.

1.2 LOCATION AND DESCRIPTION OF THE PROJECT

The site of the proposed Parcel 4 Hotel is at the northeastern end of the Charlestown Navy Yard southeast of Buildings 199, 75, 106, and also northeast of the existing Rowhouses at Parcel 4A.

Figure 3 depicts the configuration of the site that is considered to be the build condition for the assessment. Building A of the Biomedical Research Center is assumed to exist. The ell that currently runs southwest at the north end of Building 114 has been removed to allow Sixteenth Street to be extended to Chelsea Street, and a 96 foot high addition has been added at the south end of Building 114, extending it toward the edge of the Little Mystic Channel. The currently existing Buildings 218A, 210, 178, 193, 203, 131, 165, and 226, all shown in the Land Parcel Plan, Alternate 2, are assumed razed and not replaced. Buildings 77, 104, 187, 214, 206, and 215c, also shown on the Alternate 2 plan, have already been razed.

Building numbers are given in Figure 3. For this wind assessment it is important to know the relative heights of all the buildings. They are listed below:

| Building | Roof Edge Height
(feet) | Height
at Highest Point
Of Building Roof
(feet) |
|------------|----------------------------|--|
| P | 27 | 35 |
| 75 | 15 | 27 |
| 106 | 42 | 59 |
| 114 | 48 | 48 |
| 199 | 108 | 108 |
| 266 | 31 | 40 |
| Rowhouses | 23 | 30 |
| | 50 | 75 |
| Hotel | 135 | 148 |
| | 105 | 115 |
| | 75 | 92 |
| | 30 | 30 |
| Building A | 140 | 140 |

The discussion in this report will be restricted to those areas that pedestrians will be expected to use. Thus, wind conditions at all building entrances and the approaches to them along the Harborwalk in the Yard's End Park will be covered.

1.3 DESCRIPTION OF THE AREA SURROUNDING THE PROJECT

The east end of the Charlestown Navy Yard is a very exposed site. The Little Mystic Channel runs east-west just north of the site, and the Mystic River and Boston Inner Harbor lies to the east and south. Only to the west and the southwest are there significant buildings. Most are 30-50 feet high, but there are a couple of exceptions: Building 149, about the same height as Building 199, lies to the southwest, just across Thirteenth Street from Building 199; Building 197 at about 120 feet in height lies a little more to the south and about 1400 feet away. Downtown Boston, including the Financial District with its many 25-40 story buildings, lies across the Boston Inner Harbor about 1.75 miles SSW of the site.

2. THE WIND CLIMATE

2.1 VARIATION OF AVERAGE VELOCITY WITH HEIGHT

In general, the natural wind is unsteady (i.e., it is gusty), and its average velocity increases with height above the ground. Figure 5 depicts approximately how the average velocity varies with height for different types of terrains. Although generally it does not happen, when one puts up any building, the possibility exists that the building will bring the higher speed winds at the top of the building down to ground level.

Monolithic buildings (i.e., those that do not change shape with height), if they are significantly taller than most of the surrounding buildings, almost invariably will be windy at their bases. However, when there are many buildings of similar height in an area, the buildings tend to shelter one another.

2.2 STATISTICAL DESCRIPTION OF WIND

The site is about 1.75 miles from downtown Boston and about 2.25 miles west of Logan Airport. Thus, the wind data from Logan Airport typically used to define winds for Boston are applicable. Figure 6 depicts a wind rose for Boston. As noted in the figure, the windrose is based on surface wind data from Logan Airport taken from 1945 to 1965. The length of each line radiating from the center of the figure to the outermost crossing line is proportional to the total time the wind comes from that direction. The other lines crossing the radial lines are winds less than 3, 12, and 25 mph.

Figure 6 shows that the winds in Boston come primarily from the NW, W, and SW. Figures 7-10 show wind roses for Boston for winter (Dec., Jan., and Feb.), spring (Mar., Apr., and May), summer (Jun., Jul., and Aug.), and fall (Sep., Oct., and Nov.).

These figures show that NW winds tend to occur in the winter and SW winds in the summer. Spring and fall are transitional, but winds are stronger in the spring than in the fall. Strong easterly winds usually occur during storms when there is precipitation. Northwest winds blow across the Mystic Tobin Bridge and straight down Thirteenth and Sixteenth Streets. Southwest winds blow up First, Third, and Fifth Avenues. The effect of these winds as well as easterly storm winds is discussed below separately.

The average wind speed at Logan Airport at 58 feet (the average height at which the data were taken) is 12.9 mph. At pedestrian level (i.e. chest height, 4.5 feet), it is about 8 mph. The average wind speed at 58 feet at Logan Airport for each month is shown in Figure 11. Seasonally, the average is 14.2 mph in the winter, 13.9 mph in the spring, 11.2 mph in the summer, and 12.3 mph in the fall. However, the fastest hourly wind for a 100 hour return period is slightly faster in the spring than in winter.

3. CRITERIA

Since the early 1980's, Boston has used the guideline criterion for acceptable winds of not exceeding a 31 mph effective gust more often than once in 100 hours. The effective gust is defined as the average plus 1.5 times the root mean square variation about the average (rms).

In 1978, Melbourne developed probabilistic criteria for pedestrian level winds which account for different types of pedestrian activity as well as safety aspects of such winds (see Figure 12). He defined five categories for pedestrian level winds:

- 1) Dangerous and Unacceptable.
- 2) Uncomfortable for Walking.
- 3) Comfortable for Walking.
- 4) Comfortable for Short Periods of Standing or Sitting.
- 5) Comfortable for Long Periods of Standing or Sitting.

These criteria are not absolute (any location can have dangerous winds in a hurricane); rather they imply that the location would have winds speeds such as that the activity suggested is possible most of the time, and would be perceived as such by most people who are at the location frequently. For example, winds at pedestrian level at Logan Airport are just in the Category 2, uncomfortable for walking, and just under the guideline 31 mph effective gust wind speed.

4.0 PEDESTRIAN WINDS AT THE SITE

4.1 INTRODUCTION

In the following sections, the effects of the NW winter winds, the SW summer winds, and easterly storm winds will be discussed for the Build conditions defined in Figure 3.

For the most part, the weather in New England is dominated by either large coastal storms (fall, winter, and spring) or the Bermuda High (summer). Typically, when a coastal storm occurs, it rains or snows for four to twelve hours, then it clears, and the wind blows from the northwest for three or four days before the next weather system arrives. These storms, and the northwest winds following them, occur mostly in the fall, winter, and spring. Northwest winds are particularly uncomfortable in the winter, when typically they occur on cold days. The Bermuda High is responsible for the southwest winds that occur in the summer.

4.2 NW (WINTER) WINDS (FIGURE 13)

As previously noted, NW winds blow across the Mystic Tobin Bridge and directly down Thirteenth and Sixteenth Streets. They can be very uncomfortable on a cold winter day.

Currently, accelerated NW winds probably occur under the pedestrian overpasses at the corner of Thirteenth Street and Third Avenue (see Figure 13). The main pedestrian entrances to both Buildings 199 and 149 are under these overpasses. Normally, one would expect the winds there to be high in Category 3 or low in Category 2. But the Mystic Tobin Bridge is about the same height as Building 199 in that area and probably significantly reduces the NW winds coming at the upper stories of Building 199. As a result, winds at those entrances are probably no worse than high in Category 3.

The removal of the ell on Building 114 to allow Sixteenth Street to be extended to intersect Chelsea Street opens Sixteenth Street up to NW winds coming under the Mystic Tobin Bridge. The removal of Building 217 opens the gap further. The addition of the 96 foot high ell on the east side at the south end of Building 114 brings that end of Building 114 out towards the edge of the Little Mystic Channel and to a height 44 feet less than Building A of the Biomedical Research Center (Figure 3). Thus, it is to be expected that there will be significant acceleration of NW winds in Sixteenth Street between Buildings 199 and 114 as well as between Building 199 and Building A of the Biomedical Center. This will be especially true under the pedestrian overpass between Building 199 and Building A where it seems likely winds would be high in Melbourne Category 3.

Normally, Sixteenth Street between Building 199 and Building 114 would be windy now, since Building 199 is twice as tall as any of the upwind buildings. That is, one would expect the higher winds to be brought down from the top of Building 199. But with the Mystic Tobin Bridge upstream, the winds at both the north and west corners of Building 199 are accelerated, but not as much as without the Mystic Tobin Bridge. It seems likely that the winds at the north corner of Building 199 will be in mid or high Melbourne Category 3, and those at the west end in mid or low Category 3.

The main entrance to Building A in its SE wall will be in the lee of Building A for NW winds and, thus, probably in Category 4 or 5.

The Harborwalk along the Little Mystic Channel and the Mystic River will probably be high in Melbourne Category 3 due to its very exposed nature (its exposure is similar to that at Logan Airport). However, at its northernmost point, where it rounds the north corner of the 96 foot high addition to Building 114, it may be in low Category 2 (Figure 13). Toward the Harborwalk's southern end, particularly near the Rowhouses, it will be less windy (low Category 3), since much of the walk in that area is in the lee of many buildings.

For the same reasons, the Yard's End Park will be quite windy (Category 3) for this initial condition, excepting for that part which is in the lee of Building A.

The addition of the Hotel will not affect any of the conditions just described as those sites are upwind or far to the east of the Hotel. The Hotel has three entrances. The one on First Avenue is in the middle of the 30-foot high base and shielded by both Building 106 across First Avenue and Building 199 further upstream. Winds there will be in Category 4 for NW winds. The second entrance, at the southeast end of the 135-foot high wing, is in the lee of that building for NW winds and probably in Category 5. The main entrance to the Hotel is at the ground floor of the 30-foot base of the 135-foot building and thus very protected from all winds. Just to the east of the entrance, pedestrian level winds would be in Melbourne Category 3, if that area were not in the lee of Buildings 199 and A. Actually, wind conditions there will probably be high in Category 4 or low in 3. The addition of the Hotel will reduce the winds on the Harborwalk to the south of the Hotel.

4.3 SW (SUMMER) WINDS (FIGURE 15)

The prevailing winds in the summer are from the SW. SW winds approach the site coming directly up First and Fourth Avenues from the southwest end of the Yard. It should be born in mind that, on hot days, some windiness may be desirable.

For SW winds, with the exception of Buildings 149 and 197, all upwind buildings are 2 to 5 stories and act to shield the buildings of similar height on the site (P, 75, 106, 266, and the Rowhouses). Building 149 is the same height as Building 199, and is just across Thirteenth Street and slightly displaced to the southeast. As such, it provides considerable shielding for Building 199. Thus, the south corner of Building 199 is probably never windy for SW winds, and the west corner only somewhat windy for the more westerly of these SW winds (Melbourne 3 at most; see Figure 15). At the entrances to Buildings 149 and 199 under the overpass between Buildings 149 and 199, the winds could be low in Category 3.

For SW winds, the corner of Fifth Avenue and Sixteenth Street may be somewhat windy due to Building 114 deflecting the wind SE down Sixteenth Street (Category 4). However, probably there will be a strong squirt of wind up the alleyway between Buildings 114 and A (Category 3; see Figure 15).

SW winds will cause accelerated flow around the south corner of Building A as

shown in Figure 15 (Category 3). But these winds probably will not affect the main entrance to Building A, so that winds there will be in Category 4 or 5.

Most of the Harborwalk and the Yard's End Park are always in the lee of Navy Yard buildings for SW winds and, thus, the entire Harborwalk will be quite pleasant in the summer (probably in Melbourne 4 or 5). However, where Harborwalk passes the small tower at the SE end of the Rowhouses, there may be some windiness (Melbourne 3). With the addition of the Hotel, the winds on the Harborwalk to the NE of the Hotel will be reduced because that part of the Harborwalk will be in the lee of the Hotel.

Also, because the tower at the NW end of the Rowhouses is considerably taller than any of the buildings upwind of it, for SW winds its west corner may be a little windy (Melbourne 3).

Finally, the main entrance to the Hotel will be in the lee of the Hotel and, thus, very calm (Category 4). However, the entrance on First Avenue will be exposed to the winds coming down First Avenue (Category 4). Similarly, the entrance at the south end of the 135-foot high Hotel tower may be a little windy (Category 3 or 4).

4.4 STORM (EASTERLY) WINDS (FIGURES 17, 19, AND 21)

Easterly winds occur about one third of the time. Light easterly winds occur as a storm first starts or, in the summer, as a sea breeze. During the first 4-12 hours of a typical coastal storm, it rains or snows depending on the temperature, and the wind is generally from the NE or SE depending on whether the center of the storm passes to the E or W of the city.

Strong easterly winds, generally occur when it is snowing or raining. Thus, the emphasis in the following discussion will be on entering or exiting the various buildings.

For NE, E, and SE winds there will be some accelerated flow at the entrances to Buildings 149 and 199 under the pedestrian overpasses on Thirteenth Street. SE winds will cause the worst conditions (high Category 3). SE winds will also cause a squirt of wind around the east corner of Building 149 into Thirteenth Street, toward the entrances under the pedestrian overpasses (see figure 21). The addition of the Hotel will tend to alleviate these windy areas for the SE winds.

Sixteenth Street between Buildings 199 and 114 and between Building 199 and Building A of the Biomedical Center will be in the lee of Buildings 116 and A for NE and E winds, but will experience accelerated flows for SE winds. Thus, the entrance to Building A under the pedestrian overpass will probably be quite windy (Category 3) for SE winds. The addition of the Hotel will tend to reduce these winds for SE winds.

The main entrance to Building A at its SE end will be particularly windy for both NE and E winds (high Category 3 and possibly low 2), but not as windy for SE winds. It would appear that, for most storms, one of the two entrances to Building A probably

would be protected for the existing conditions. The addition of the Hotel will not affect these conditions.

Most of the Harborwalk will be in high Category 3 or low 2 for all these easterly winds. However, the Harborwalk near one of the two north corners of the 96 foot high addition to Building 114 will experience winds that probably exceed the BRA guideline 31 mph effective gust wind speed. While not as great, the flow in the Harborwalk near the tower at the southeast end of the Rowhouses will also be accelerated for these winds (high Category 3). The addition of the Hotel will not affect these conditions.

The entrance to the Hotel on First Avenue will experience some windiness (low Category 3) for NE and E winds, but will be sheltered for SE winds. The entrance to the Harborwalk at the southeastern end of the 135-foot tower will also be windy for NE and E winds (High Category 3), but less windy for SE winds. The main entrance, because it is on the ground floor of the 30-foot base of the 135-foot tower, will be protected from all of these easterly winds.

5. SUMMARY

An assessment of the effect of adding the Parcel 4 Hotel to the Charlestown Navy Yard complex has been made. The assessment conditions for build conditions are depicted in Figure 1. Winds at the entrances to the Hotel are acceptable for most wind directions.

Wind conditions in Yard's End Park at the SW where most pedestrian traffic is expected and along other pedestrian pathways remain relatively unaffected under build conditions.

However, First Avenue will be slightly worsened by the corridor effect of the Parcel 4 Hotel under some wind conditions, notably storm conditions. While wind conditions over the rest of Harborwalk will still be windy at times, this is a result of the exposed nature of the Harborwalk.

6. MITIGATION

Any worsening of wind conditions caused by the Parcel 4 Hotel will be lessened under the proposed Full Build conditions in the future. Temporary screens such as tree and shrub plantings or a screen wall could be erected in the interim. Awnings, street trees, and pedestrian arcades and other variations in the Hotel's facade plane will also serve to lessen any wind impacts.

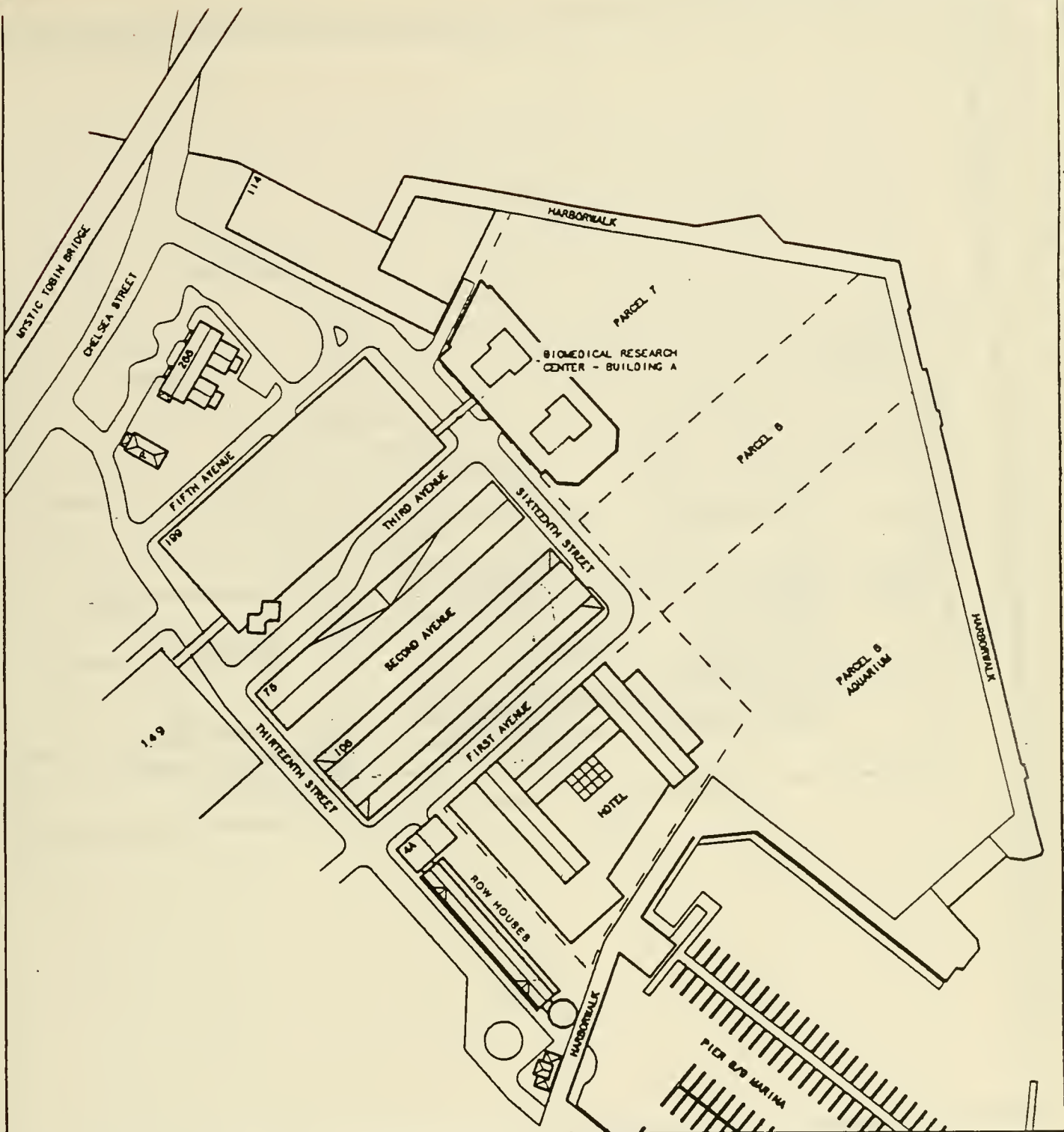


Figure 1 Study Conditions Base

Charlestown Navy Yard
Parcel 4 Hotel
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

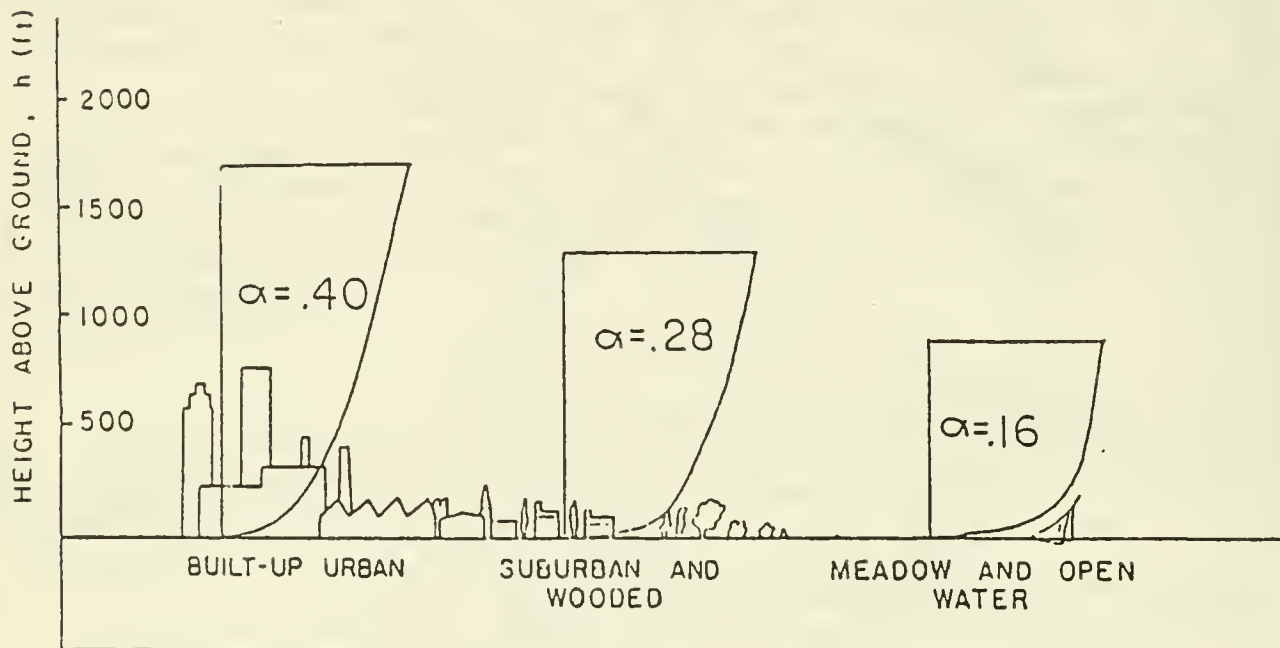


Figure 5

Types Of Earth's Boundary Layer — — Davenport

Charlestown Navy Yard
Parcel 4 Hotel
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

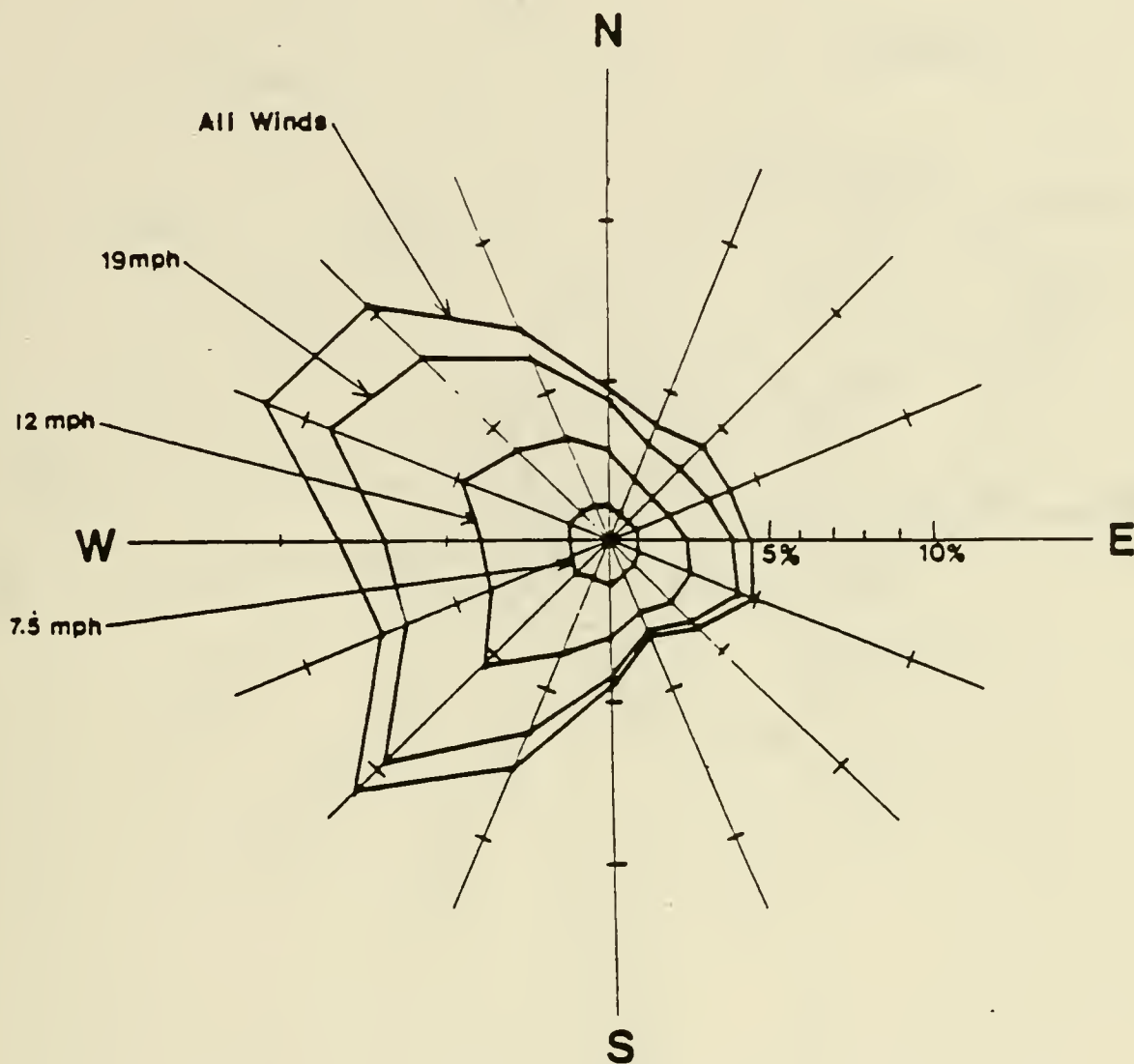


Figure 6 Boston Wind Rose For The Year
Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Parcel 4 Hotel
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

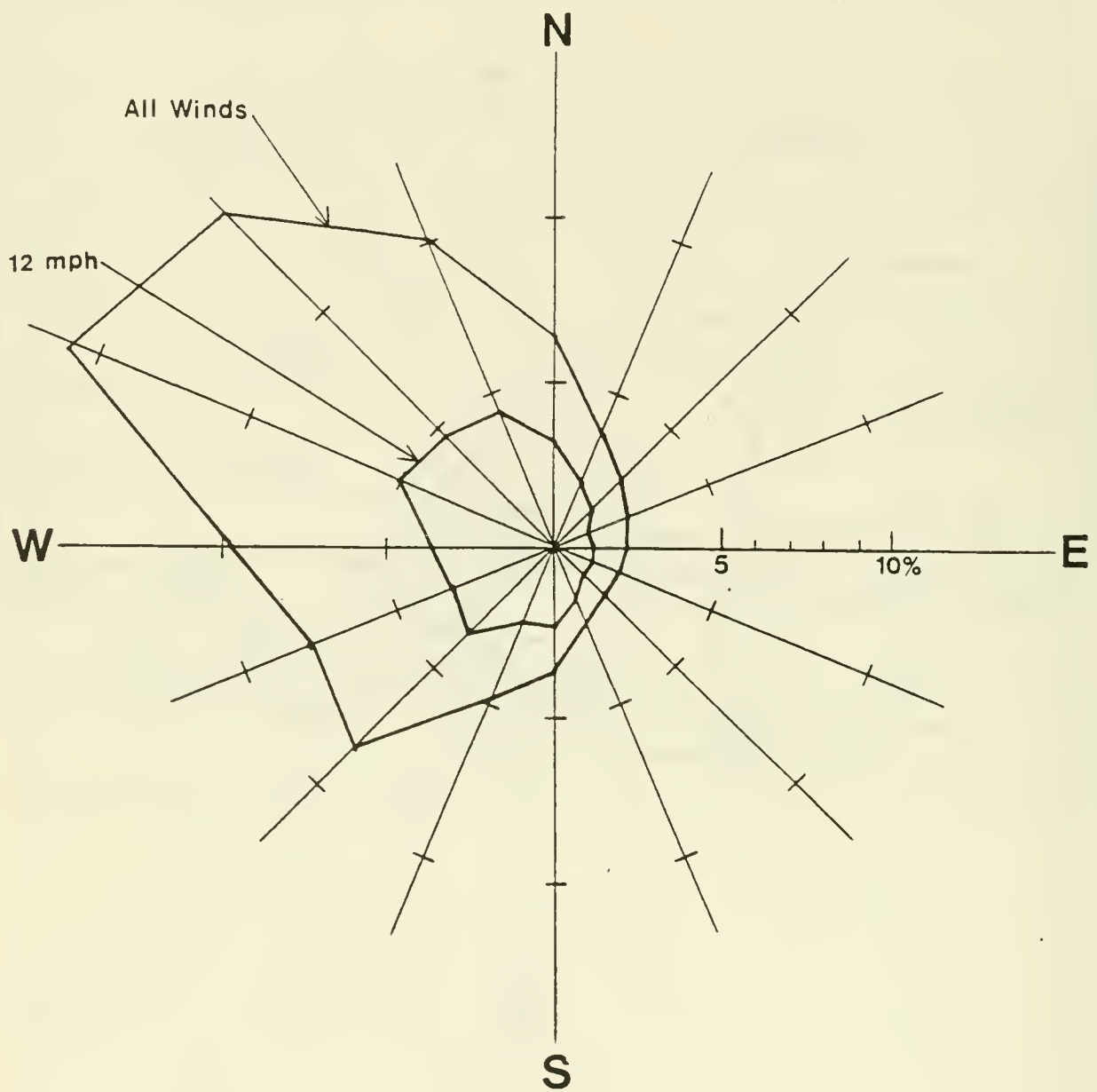


Figure 7

Boston Wind Rose For The Winter (December, January, February)

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard

Parcel 4 Hotel

Wind Assessment

Prepared By: Frank H. Durgin, P.E.

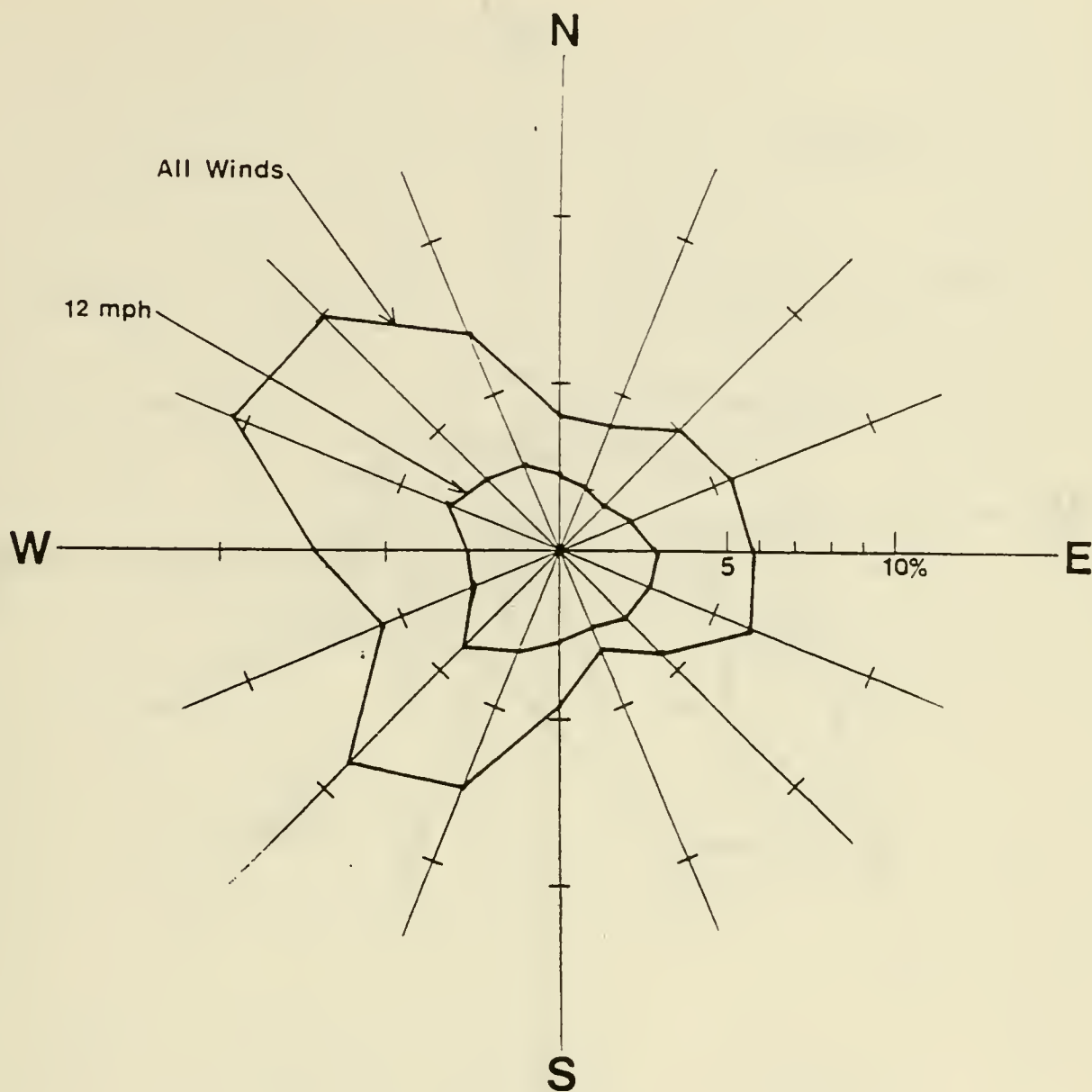


Figure 8

Boston Wind Rose For The Spring (March, April, May)

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Parcel 4 Hotel
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

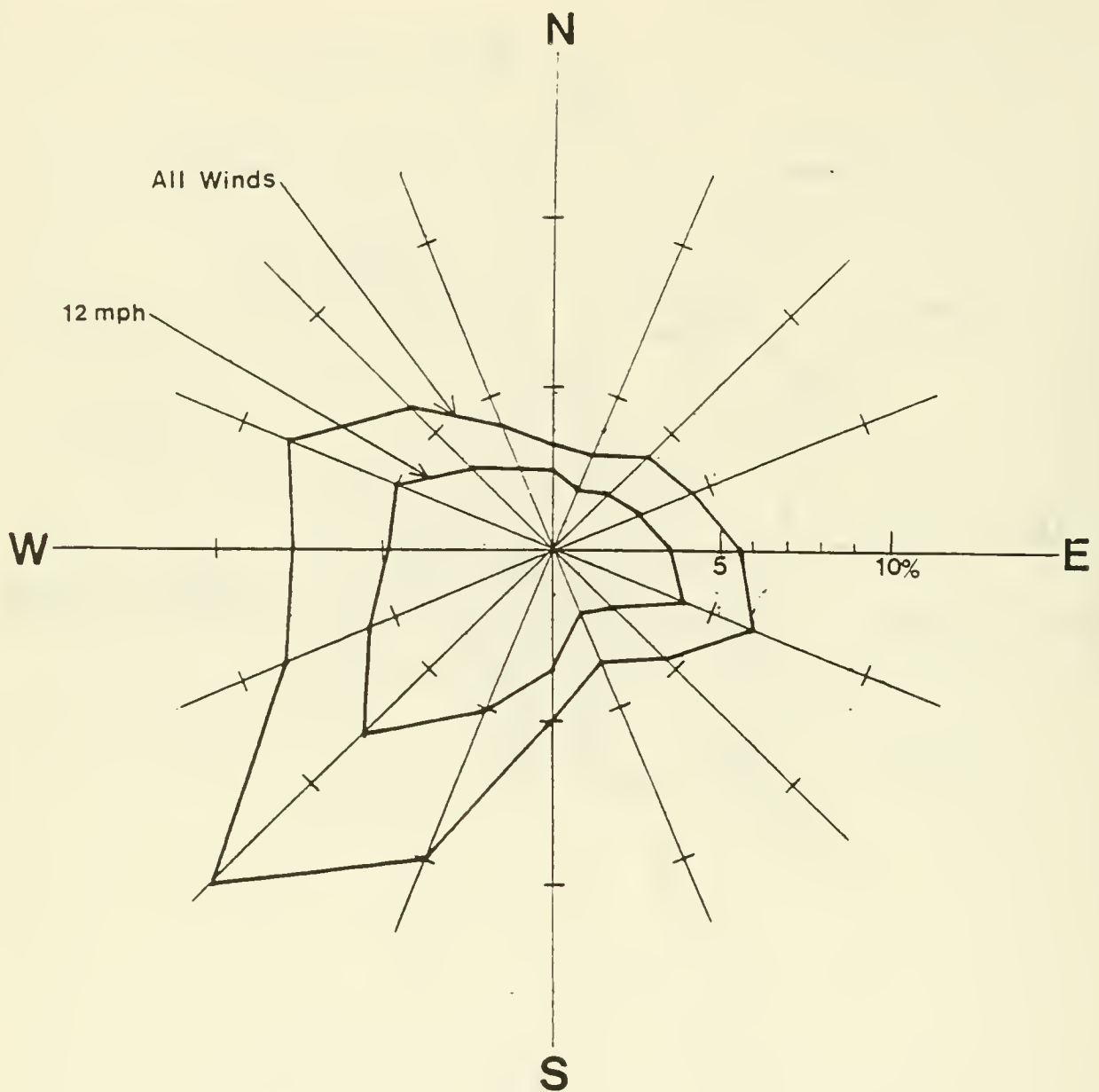


Figure 9

Boston Wind Rose For The Summer (June, July, August)

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Parcel 4 Hotel
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

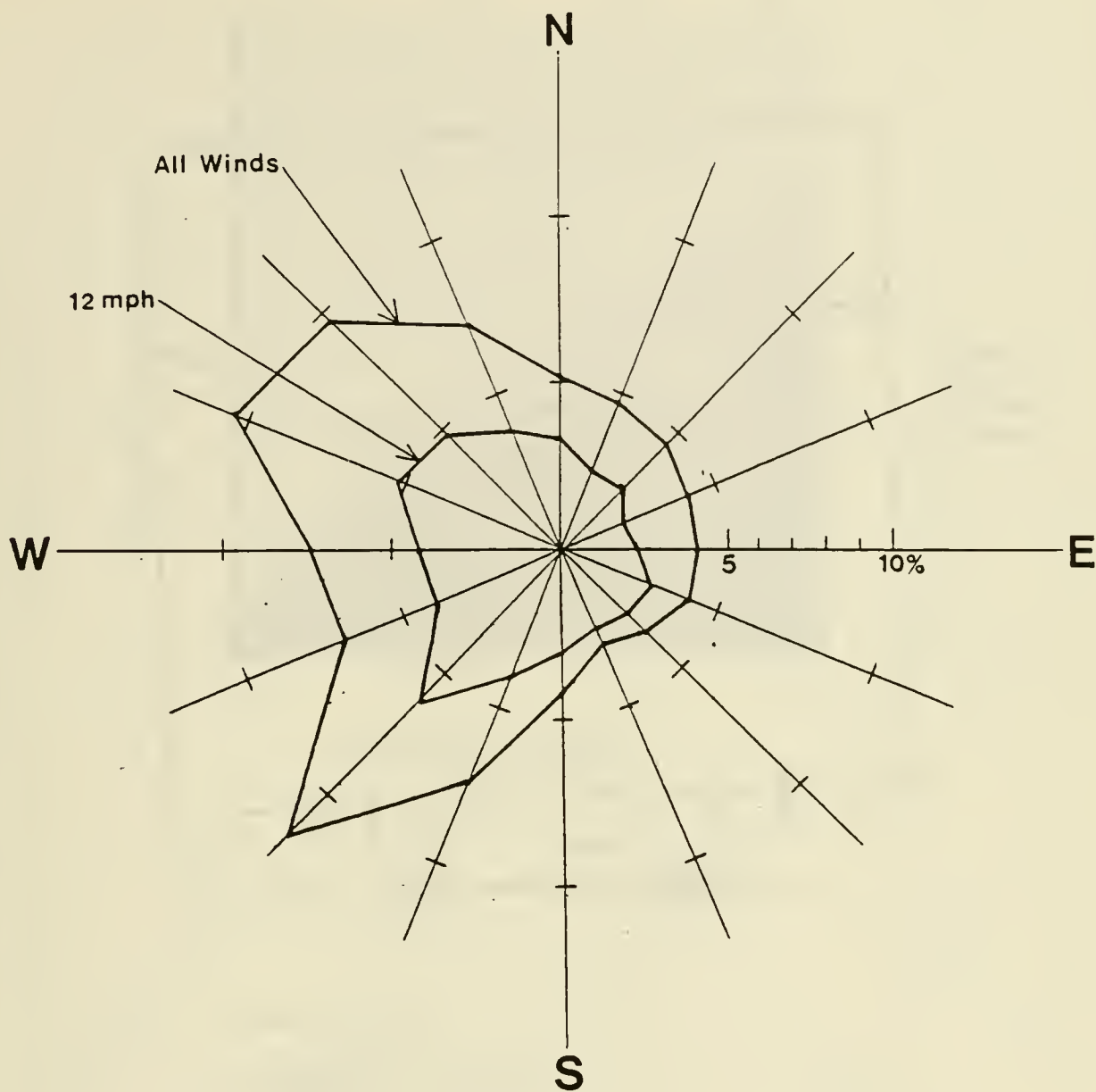


Figure 10 Boston Wind Rose For The Fall (September, October, November)
Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Parcel 4 Hotel
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

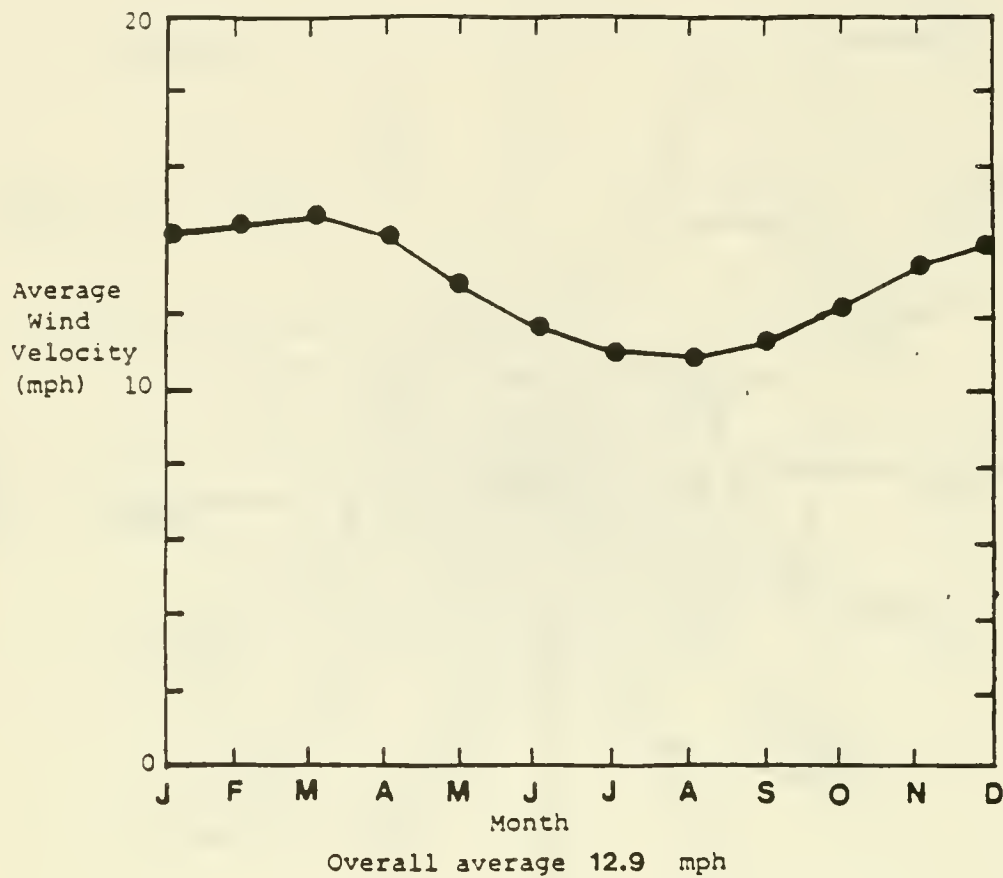
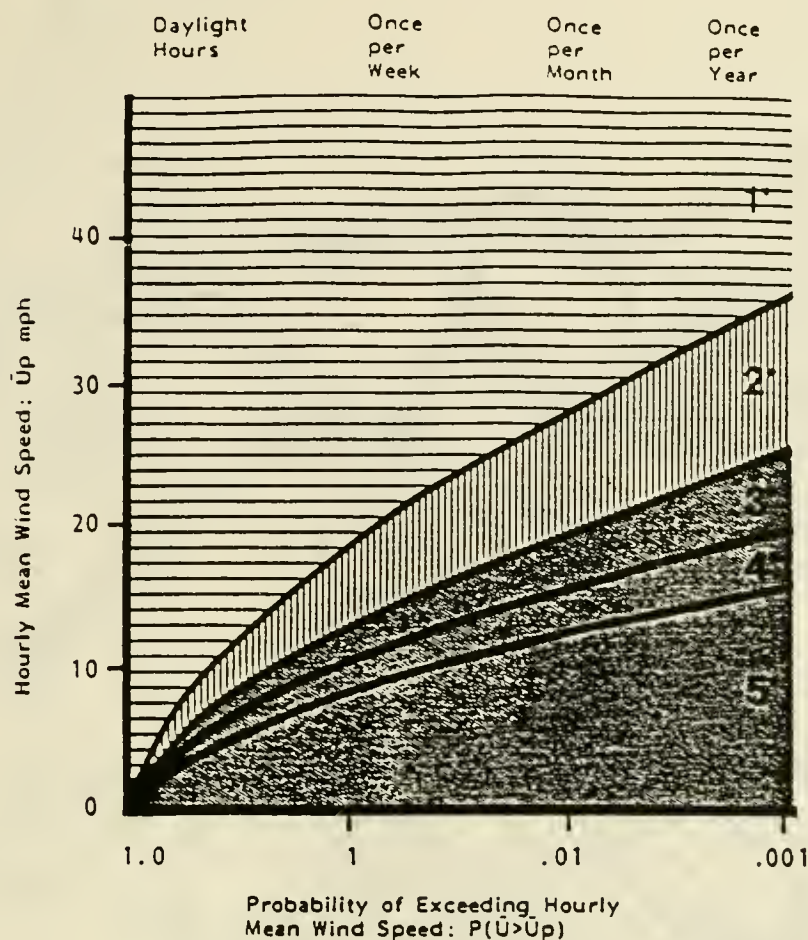


Figure 11

Average Wind Velocity At Logan Airport At 58 ft, 1945-1965, By Month



 Dangerous
  Uncomfortable
  Comfortable

* Melbourne's Category

- 1 Unacceptable and dangerous
- 2 Uncomfortable for walking
- 3 Acceptable for walking
- 4 Acceptable for short periods of standing or sitting
- 5 Acceptable for long periods of standing or sitting

Figure 12

Melbourne's Category

Charlestown Navy Yard
 Parcel 4 Hotel
 Wind Assessment
 Prepared By: Frank H. Durgin, P.E.

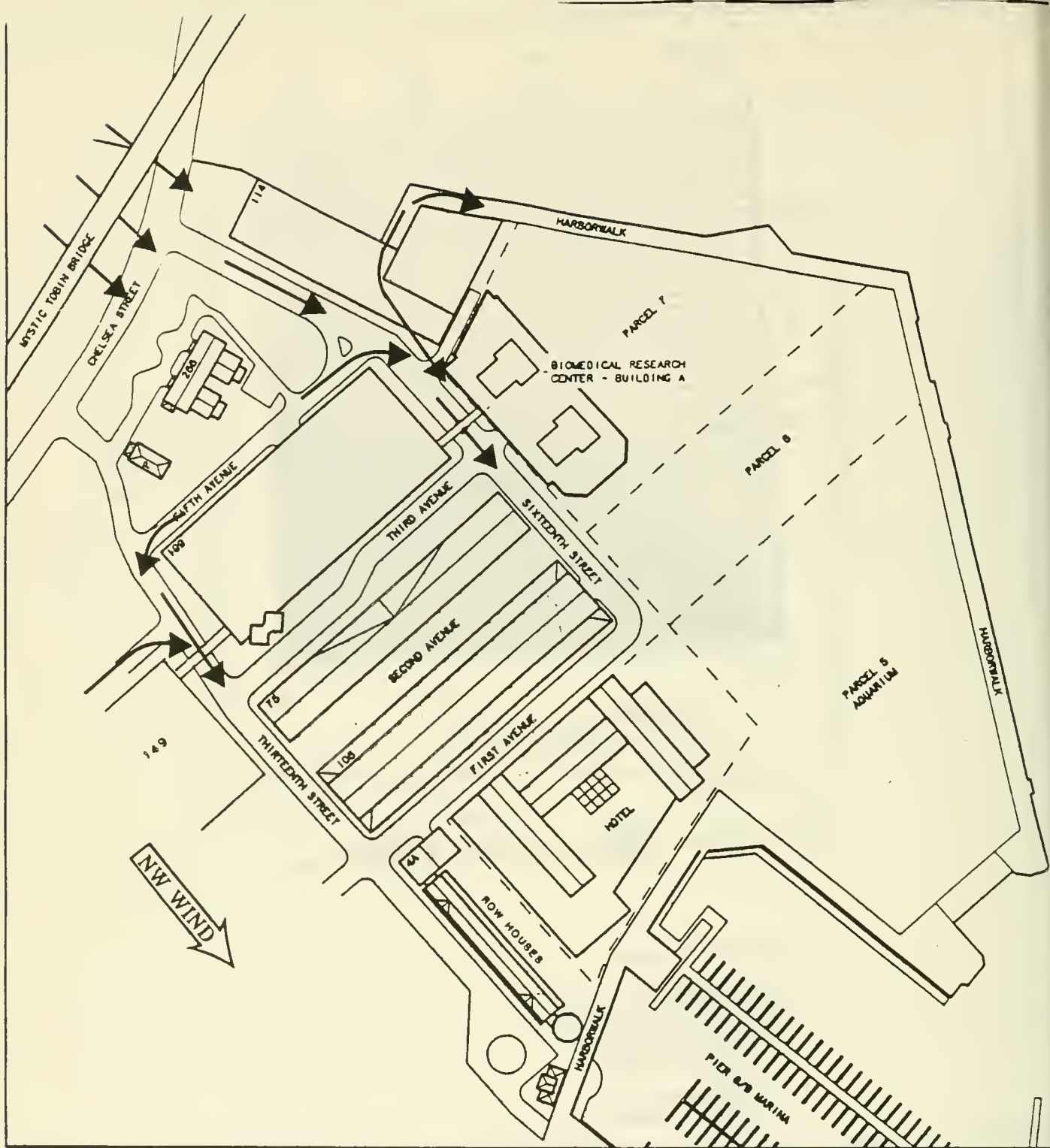


Figure 13

Wind Flow Patterns - Wind From Northwest

Charlestown Navy Yard
Parcel 4 Hotel

Wind Assessment
Prepared By: Frank H. Durgin, P.E.

Charlestown Navy Yard
Parcel 4 Hotel
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

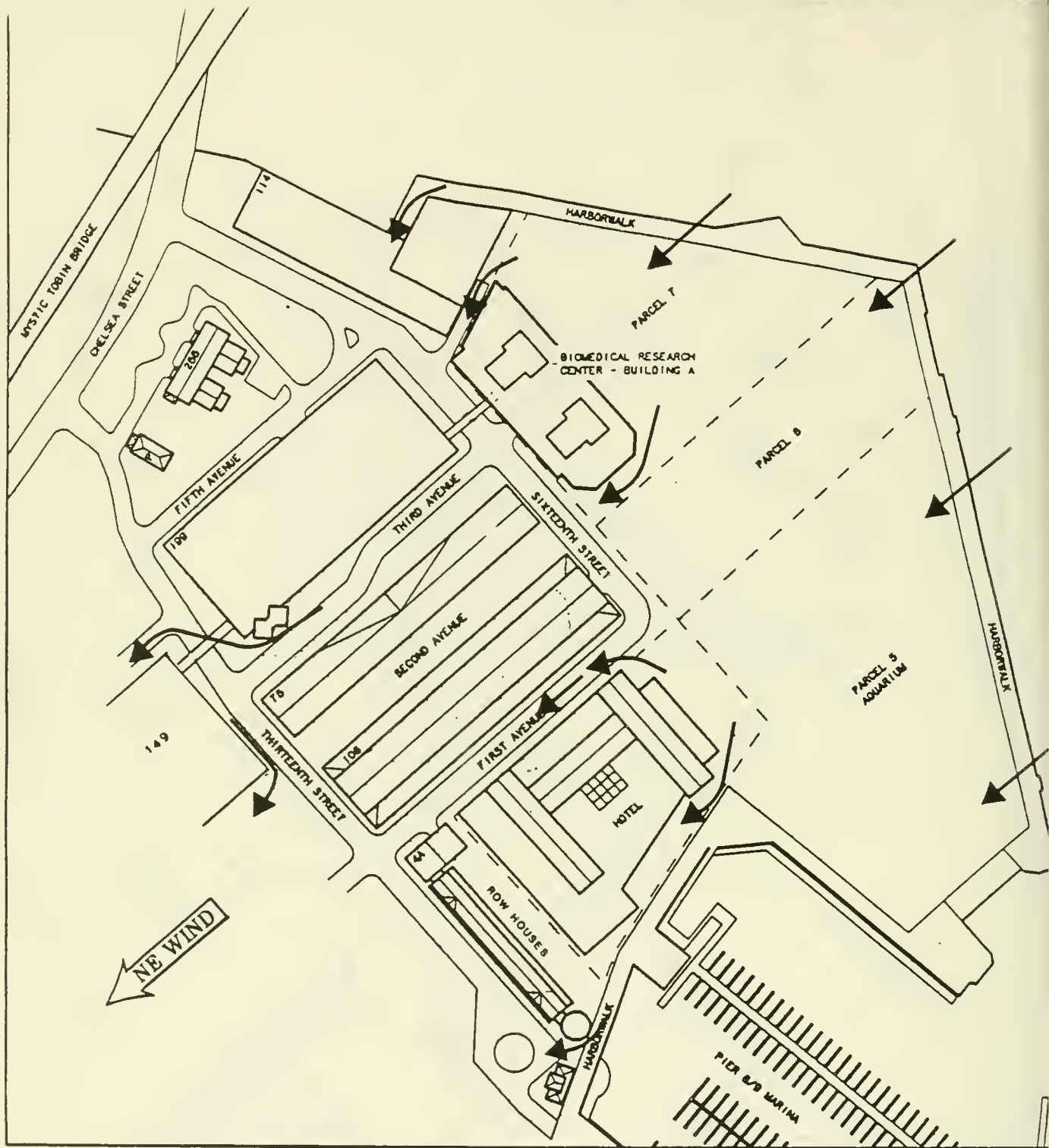


Figure 17

Wind Flow Patterns - Wind From Northeast

Charlestown Navy Yard
Parcel 4 Hotel

Wind Assessment
Prepared By: Frank H. Durgin, P.

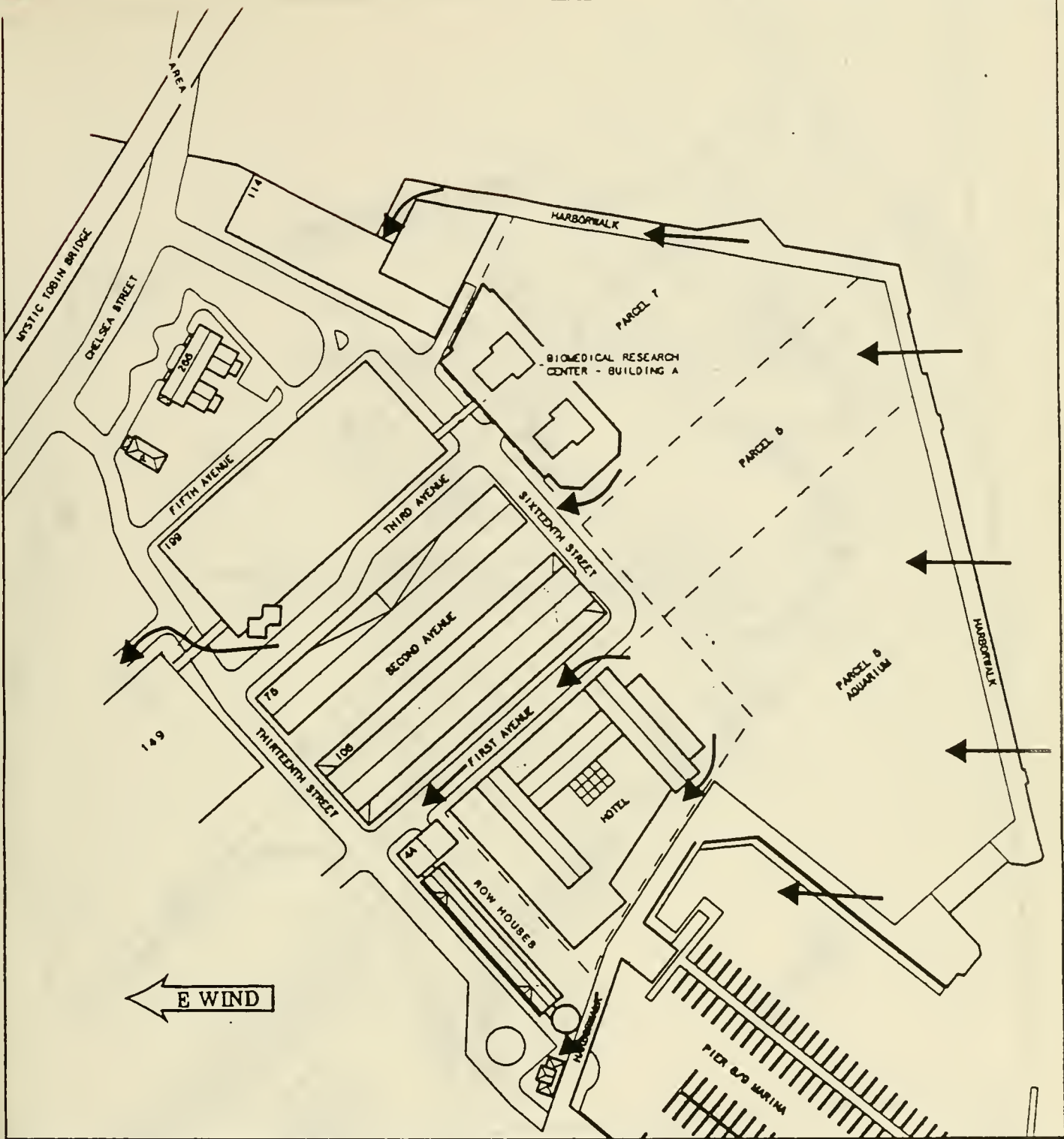
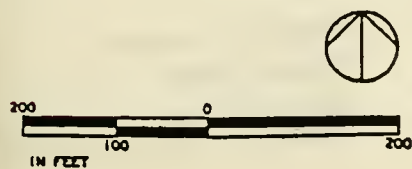


Figure 19

Wind Flow Patterns - Wind From East

Charlestown Navy Yard
Parcel 4 Hotel
Wind Assessment
Prepared By: Frank H. Durgin, P.E.



← Local Wind Direction

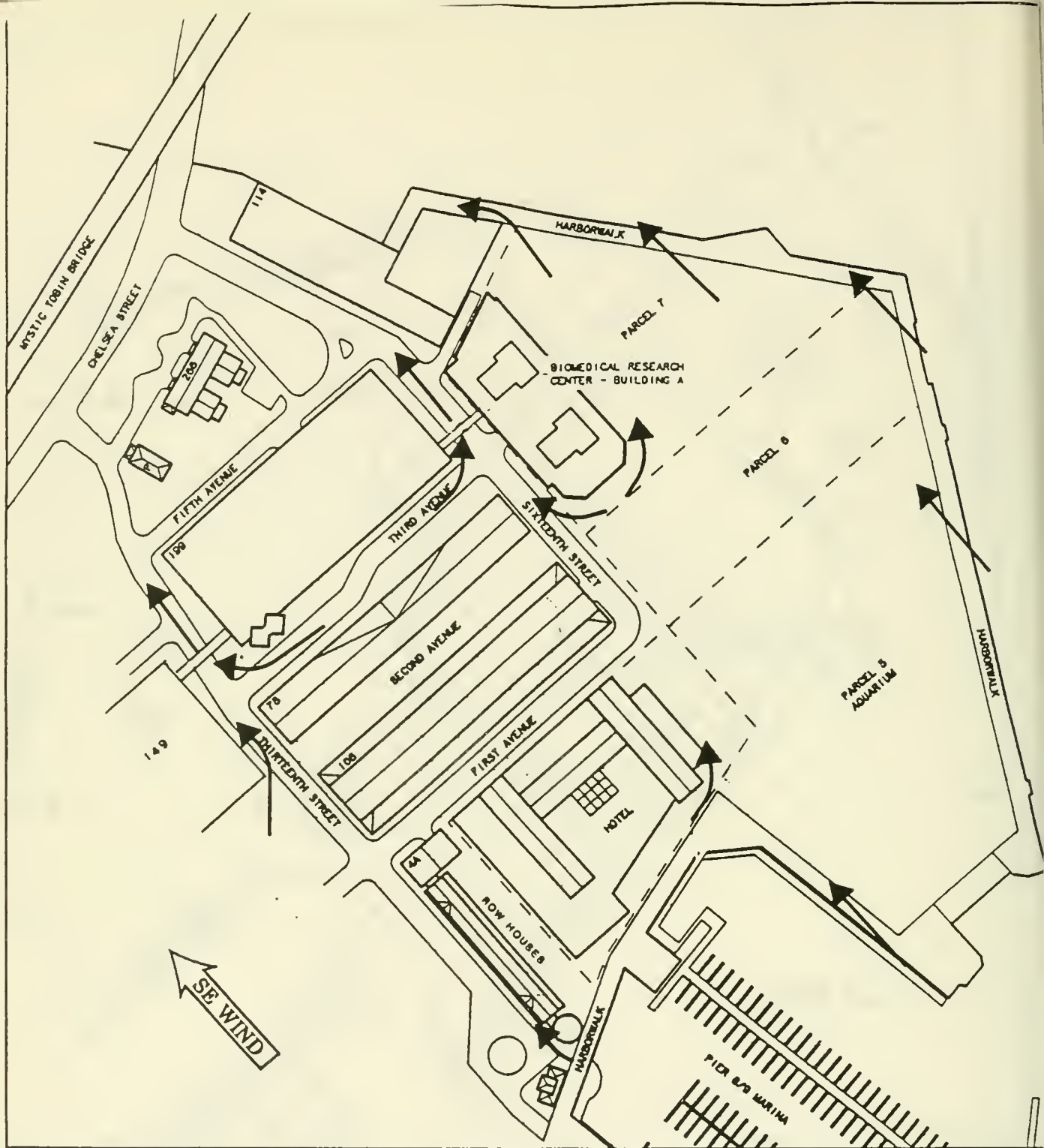
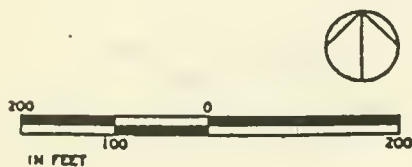


Figure 21

Wind Flow Patterns - Wind From Southeast

Charlestown Navy Yard
Parcel 4 Hotel
Wind Assessment
Prepared By: Frank H. Durgin, P.



← Local Wind Direction

APPENDIX F3

**BUILDINGS B AND C OF THE BIOMEDICAL RESEARCH CENTER
AND THE NEW ENGLAND AQUARIUM**

Job 91-2299

**An Assessment of Pedestrian Level Winds for the Proposed
New England Aquarium and
New Buildings B and C of The Biomedical Research Center in
the Charlestown Navy Yard, Boston, Massachusetts**

August 20, 1991

By:

Frank H. Durgin, P.E.

Submitted To:

Sasaki Associates, Inc.

Prepared for:

Boston Redevelopment Authority

**An Assessment of Pedestrian Level Winds for the Proposed
New England Aquarium and Buildings B and C of The Biomedical Research Center
in The Charlestown Navy Yard, Boston, Massachusetts**

Frank H. Durgin, P.E.

1.0 INTRODUCTION

1.1 Basis

This evaluation of pedestrian level winds was performed at the request of Mr. Jonathan Warner of Sasaki Associates, Inc. It is based on:

- 1) The drawings listed below received from Jonathan Warner:
 - a) Charlestown Navy Yard Master Plan dated June 1991;
 - b) A similar drawing (unnamed and no date) with isometrics of buildings at an interim stage;
 - c) Three drawings containing N, E, S, and W elevations, and transverse and longitudinal sections of the new New England Aquarium dated Nov. 1989;
 - d) The Boston Navy Yard - Charlestown, Land Parcel Plan Alternate 2, prepared by Parsons, Brinkerhoff, Quade, & Douglas, dated Nov. 5, 1976;
 - e) City of Boston Topographic and Planimetric Map No. 19N-13E, revised 1988;
 - f) Map giving Existing Building Heights for the Charlestown Navy Yard (no date);
 - g) Elevations and Plan views for Buildings 75, 105, 106, 114, 199, 266, and for the Rowhouses on Thirteenth Street (Various dates and sources).
 - h) Section, Ground Floor Plan, and Atrium Floor Plan for Phases A, B, and C of the Biomedical Research Center dated May 21, 1991 and annotated by Don Klabin, July 10, 1991.
 - i) Two 8.5 by 11 inch drawings showing the buildings to be included in the existing and build conditions used for this study. These, with building numbers added, are included as Figures 1 and 2;
- 2) Two site visits during which 28 photographs were taken of the buildings on the site and the site's surroundings;
- 3) An evaluation of the urban context of the proposed project;
- 4) A review of wind climate data for Boston; and
- 5) The author's 22 years of experience dealing with pedestrian level winds.

The interaction of the wind with buildings and structures is very complicated and, at times, unpredictable. Thus, this evaluation must be treated as a qualitative assessment of pedestrian level winds.

1.2 Location and Description of the Project

The site of the proposed new New England Aquarium and Biomedical Research Center is at the east end of the Charlestown Navy Yard southeast of Building 114. The Biomedical Research Center is northeast of Buildings 199, 75, and 106 and is also northeast of a Hotel that will be built northeast of the existing set of Rowhouses. The new New England Aquarium is southeast of Buildings 199 and 75 and to the east of Building 106 and the proposed Hotel.

The site is currently partly occupied by Buildings 218A, 210, 178, 193, 203, 131, and 266.

Figure 1 depicts the configuration of the site that is considered to be existing conditions for this assessment. Building A of the Biomedical Research Center and the Hotel southeast of First Avenue and opposite Building 106 are assumed to exist. The ell that currently runs southwest at the north end of Building 114 has been removed to allow Sixteenth Street to be extended to Chelsea Street, and a 96-foot high addition has been added at the south end of Building 114, extending it toward the edge of the Little Mystic Channel. The currently existing Buildings 218A, 210, 178, 193, 203, 131, 165, and 226, all shown in the Land Parcel Plan, Alternate 2, are assumed razed and not replaced. Buildings 77, 104, 187, 214, 206, and 215c, also shown on the Alternate 2 plan, have already been razed.

Figure 2 is identical to Figure 1 except that the new New England Aquarium and Buildings B and C of the Biomedical Research Center have been added to the site.

Building numbers are given in both Figures. For this wind assessment it is important to know the relative heights of all the buildings. They are given in Figure 3 and listed below:

| Building | Roof Edge Height
(feet) | Height at Highest
Point of
Building Roof
(feet) |
|-----------|----------------------------|--|
| P | 27 | 35 |
| 75 | 15 | 27 |
| 106 | 42 | 59 |
| 114 | 48 | 48/96 |
| 199 | 108 | 108 |
| 266 | 31 | 40 |
| Rowhouses | 23 | 30 |
| | 50 | 75 |
| Aquarium | 50 | 95 |
| | 50 | 82 |
| | 30 | 82 |
| Hotel | 135 | 148 |
| | 105 | 114 |
| | 75 | 92 |
| | 30 | 30 |

| | | |
|------------|-----|-----|
| Building A | 140 | 140 |
| Atrium | | 140 |
| Building B | 155 | 155 |
| Atrium | | 110 |
| Building C | 110 | 110 |

The discussion in this report will be restricted to those areas that pedestrians will be expected to use. Thus, wind conditions at all building entrances and the approaches to them along the Harborwalk and in the Yard's End Park will be covered. These areas are shown in Figure 4.

In the discussion that follows, the wind conditions for the configurations depicted in Figures 1 and 2 will be compared.

1.3 *Description of the Area Surrounding the Project*

The east end of the Charlestown Navy Yard is a very exposed site. The Little Mystic Channel runs east-west just north of the site, and the Boston Inner Harbor lies to the east and south. Only to the west and southwest are there significant buildings. Most are 30-50 feet high, but there are a couple of exceptions: Building 149, about the same height as Building 199, lies to the southwest, just across Thirteenth Street from 199; and Building 197, at about 120 feet in height, lies a little more to the south and about 1400 feet away. Downtown Boston, including the Financial District with its many 25-40 story buildings, lies across the Boston Inner Harbor about 1.75 miles south-southwest of the site.

2.0 THE WIND CLIMATE

2.1 *Variation of Average Velocity with Height*

In general, the natural wind is unsteady (i.e., it is gusty), and its average velocity increases with height above the ground. Figure 5 depicts approximately how the average velocity varies with height for different types of terrains. When one puts up any building, the possibility exists, although generally it does not happen, that the building will bring the higher speed winds at the top of the building down to ground level.

Monolithic buildings (i.e., those that do not change shape with height), if they are significantly taller than most of the surrounding buildings, almost invariably will be windy at their bases. However, when there are many buildings of similar height in an area, the buildings tend to shelter one another.

The proposed Buildings A, B, and C of the Biomedical Research Center and the Aquarium are very exposed to NE and E winds, and it seems likely that E winds will cause accelerated winds at the pedestrian entrance to Building A in its SE wall before Buildings B and C are built. The need for temporary windbreaks at that entrance is described in "An Assessment of Pedestrian Level Winds for Building A of the Proposed Biomedical Research Center in the Charlestown Navy Yard, Boston, Massachusetts."

2.2 Statistical Description of Wind

The site is about 1.75 miles from downtown Boston and about 2.25 miles west of Logan Airport. Thus, the wind data from Logan Airport typically used to define winds for Boston are applicable. Figure 6 depicts a windrose for Boston. As noted in the figure, the windrose is based on surface wind data from Logan Airport taken from 1945 to 1965. The length of each line radiating from the center of the figure to the outermost crossing line is proportional to the total time the wind comes from that direction. The other lines crossing the radial lines are for winds less than 3, 12, and 25 mph.

Figure 6 shows that the winds in Boston come primarily from the NW, W, and SW. Figures 7 -10 show windroses for Boston for winter (Dec., Jan., and Feb.), spring (Mar., Apr., and May), summer (Jun., Jul., and Aug.), and fall (Sep., Oct., and Nov.). These figures show that NW winds tend to occur in the winter and SW winds in the summer. Spring and fall are transitional, but winds are stronger in the spring than in the fall. Strong easterly winds usually occur during storms when there precipitation. Northwest winds blow across the Mystic Tobin Bridge and straight down Thirteenth and Sixteenth Streets. Southwest winds blow up First, Third, and Fifth Avenues. The effect of these winds, as well as easterly storm winds, is discussed below separately.

The average wind speed at Logan Airport at 58 feet (the average height at which the data were measured) is 12.9 mph. At pedestrian level (i.e., chest height, 4.5 feet), it is about 8 mph. The average wind speed at 58 feet at Logan Airport for each month is shown in Figure 11. Seasonally, the average is 14.2 mph in the winter, 13.9 mph in the spring, 11.2 mph in the summer, and 12.3 mph in the fall. However, the fastest hourly wind for a 100-hour return period is slightly faster in the spring than in winter.

3.0 CRITERIA

Since the early 1980s, Boston has used the guideline criterion for acceptable winds of not exceeding a 31 mph effective gust more often than once in 100 hours. The effective gust is defined as the average plus 1.5 times the root mean square variation about the average (rms).

In 1978, Melbourne developed probabilistic criteria for pedestrian level winds which account for different types of pedestrian activity as well as safety aspects of such winds (see Figure 12). He defined five categories for pedestrian level winds:

1. Dangerous and Unacceptable.
2. Uncomfortable for Walking.
3. Comfortable for Walking.
4. Comfortable for Short Periods of Standing or Sitting.
5. Comfortable for Long Periods of Standing or Sitting.

These criteria are not absolute (any location can have dangerous winds in a hurricane); rather, they imply that the location would have wind speeds such that the activity suggested is possible most of the time, and would be perceived as such by most people who are at the location frequently. For example, winds at pedestrian level at Logan Airport are just in the Category 2, uncomfortable for walking, and just under the guideline 31 mph effective gust wind speed.

4.0 PEDESTRIAN WINDS AT THE SITE

4.1 *Introduction*

In the following sections, the effects of the NW winter winds, the SW summer winds, and easterly storm winds will be discussed for the Existing and Build conditions defined in Figures 1 and 2.

For the most part, the weather in New England is dominated by either large coastal storms (fall, winter, and spring) or the Bermuda High (summer). Typically, when a coastal storm occurs, it rains or snows for four to twelve hours, then it clears, and the wind blows from the northwest for three or four days before the next weather system arrives. These storms, and the northwest winds following them, occur mostly in the fall, winter, and spring. Northwest winds are particularly uncomfortable in the winter, when typically they occur on cold days. The Bermuda High is responsible for the southwest winds that occur in the summer.

4.2 *NW (Winter) Winds (Figures 13 and 14)*

As previously noted, NW winds blow across the Mystic Tobin Bridge and directly down Thirteenth and Sixteenth Streets. They can be very uncomfortable on a cold winter day.

4.2.1 *Existing Conditions (Figure 13)*

Currently, accelerated NW winds probably occur under the pedestrian overpasses at the corner of Thirteenth Street and Third Avenue (see Figure 13). The main pedestrian entrances to both Buildings 199 and 149 are under these overpasses. Normally, one would expect the winds there to be high in Category 3 or low in Category 2. But the Mystic Tobin Bridge is about the same height as Building 199 in that area and probably significantly reduces the NW winds coming at the upper stories of Building 199. As a result, winds at those entrances are probably no worse than high in Category 3.

The removal of the ell on Building 114 to allow Sixteenth Street to be extended to intersect Chelsea Street opens Sixteenth Street up to the NW winds coming under the Mystic Tobin Bridge. The removal of Building 217 opens the gap further. The addition of the 96-foot high ell on the east side at the south end of Building 114 brings that end of Building 114 out toward the edge of the Little Mystic Channel and to a height 44 feet less than Building A of the Biomedical Research Center (Figure 3). Thus, it is to be expected that there will be significant acceleration of NW winds in Sixteenth Street

between Buildings 199 and 114 as well as between Building 199 and Building A of the Biomedical Center. This will be especially true under the pedestrian overpass between Building 199 and Building A where it seems likely winds would be high in Melbourne Category 3.

Normally, Sixteenth Street between Building 199 and Building 114 would be windy now, since Building 199 is twice as tall as any of the upwind buildings. That is, one would expect the higher winds to be brought down from the top of Building 199. But with the Mystic Tobin Bridge upstream, the winds at both the north and west corners of Building 199 are accelerated, but not as much as without the Mystic Tobin Bridge. It seems likely that the winds at the north corner of Building 199 will be in mid or high Melbourne Category 3, and those at the west end in mid or low Category 3.

The Main Entrance to Building A in its SE wall will be in the lee of Building A for NW winds and, thus, probably in Category 4 or 5.

The Harborwalk along the Little Mystic Channel and the Boston Inner Harbor will probably be high in Melbourne Category 3 due to its very exposed nature (its exposure is similar to that at Logan Airport). However, at its northernmost point, where it rounds the north corner of the 96-foot extension to Building 114 it may be in low Category 2 (Figure 13). Toward the Harborwalk's southern end, particularly near the Rowhouses, it will be less windy (low Category 3), since much of the walk in that area is in the lee of many buildings.

For the same reasons, the Yard's End Park will be quite windy (Category 3) for this initial condition, except for that part which is in the lee of Building A.

The Hotel has three entrances (Figure 4). The one on First Avenue is in the middle of the 30-foot high base and is shielded by both Building 106 across First Avenue and Building 199 further upstream. Winds there will probably be in Category 4 for NW winds. The second entrance, at the southeast end of the 135-foot high building (Figure 3), is in the lee of that building for NE winds and probably in Category 5. The main entrance to the Hotel is under the 30-foot high base of the 135-foot high building and, thus, is very protected from all winds. Just to the east of the entrance, building winds would be in Melbourne Category 3, if that area were not in the lee of Buildings 199 and A. Actually, wind conditions there will probably be high in Category 4 or low in 3.

4.2.2 With the Aquarium and Buildings B and C in Place (Figure 14)

The addition of the Aquarium and Buildings B and C to the site will have little or no effect on NW winds at the SW end of Building 199 (Category 3), and they will cause no more than a slight increase to the winds coming down Sixteenth Street between Building 199 and Building 114 and Building A. The winds at the entrance to Building A under the pedestrian overpass will still be in high Category 3 or low in 2.

The courtyard entrances to Buildings A, B, and C (Figure 4) will all be in the lee of Buildings A and B and, thus, the winds at those entrances will all be in Categories 4 or 5 for NW winds.

The most northerly Harborwalk corner will remain as windy as before, but the presence of Buildings B and C will cause the winds along the Harborwalk next to Building B to increase somewhat, causing the winds there to be in low Category 2. For the more northerly of these NW winds, the winds near the Harborwalk corner next to Building C will probably be in low Category 2 and may possibly exceed the BRA guideline wind speed. Beyond that corner, to the south, the Harborwalk will be sheltered by the many buildings to the NW of it, and all areas probably will be in Category 4 or 5 for NW winds.

For NW winds, the entire Yard's End Park will be in the lee of Buildings A, B, and C. Thus, the winds in the park will be in Category 4 or 5.

Although the Aquarium is a very large building and about 100 feet in height, its many sloping roofs and setbacks probably will cause it to affect the winds about the same way as a flat-roofed 50-foot tall building of the same footprint would. For NW winds, the Aquarium is in the lee of Buildings 199, A, B, and C. It is hard to guess how the wind will be deflected as it blows at the front of the Aquarium. The most reasonable scenario is that the wind will blow down the long sloping roof and across the entrance area. However, the roof edge at the entrance area is 30 feet high and it is doubtful that these winds will reach ground level before the most westerly corner of the Aquarium (Figure 14). The more northerly west corner, just north of the main entrance, will probably have a small squirt of wind coming around it (not more than Category 3). The main entrance will probably experience winds no greater than Category 4 for these NW winds.

The Hotel entrance on First Avenue and the entrance at the SE end of the 135-foot high wing will still be quite sheltered, and have winds no worse than Category 4. On the other hand, the winds between the west corner of the Aquarium and the SE end of the main entrance to the hotel will be speeded up because of the wind being forced through the narrow gap between the Hotel and the Aquarium (See Figures 4 and 14). However, with the actual entrance to the Hotel in the arcade under the building, the winds there will probably remain in Category 5.

4.3 *SW (Summer) Winds (Figures 15 and 16)*

The prevailing winds in the summer are from the SW. SW winds approach the site coming directly up First and Fourth Avenues from the southwest end of the Yard. It should be borne in mind that, on hot summer days, some windiness may be desirable.

4.3.1 *Existing Conditions (Figure 13)*

For SW winds, with the exception of Buildings 149 and 197, all upwind buildings are 2 to 5 stories and act to shield the buildings of similar height on the site (P, 75, 106, 266, and the Rowhouses). Building 149 is the same height as Building 199, and is just across Thirteenth Street and slightly displaced to the southeast. As such, it provides considerable shielding for Building 199. Thus, the south corner of Building 199 is probably never windy

for SW winds and the west corner only somewhat windy for the more westerly of these SW winds (Melbourne 3 at most; see Figure 15). At the entrances to Buildings 149 and 199 under the overpass between Buildings 149 and 199, the winds could be low in Category 3.

For SW winds, the corner of Fifth Avenue and Sixteenth Street may be somewhat windy due to Building 114 deflecting the wind SE down Sixteenth Street (Category 4). However, probably there will be a strong squirt of wind up the alleyway between Buildings 114 and A (Category 3; see Figure 15).

SW winds will cause accelerated flow around the south corner of Building A as shown in Figure 15 (Category 3). But these winds probably will not affect the main entrance to Building A, so that winds there will be in Category 4 or 5.

Most of the Harborwalk and the Yard's End Park are always in the lee of Navy Yard buildings for SW winds and, thus, the entire Harborwalk will be quite pleasant in the summer (probably in Melbourne 4 or 5). However, where Harborwalk passes the small tower at the SE end of the Rowhouses, there may be some windiness (Melbourne 3).

Also, because the tower at the NW end of the Rowhouses is considerably taller than any of the buildings upwind of it, its west corner may be a little windy for SW winds (Melbourne 3).

Finally, the main entrance to the Hotel will be in the lee of the Hotel and, thus, very calm (Category 5). However, the entrance on First Avenue will be exposed to the winds coming down First Avenue (Category 4). Similarly, the entrance at the south end of the 135 foot high Hotel wing may be a little windy (Category 3 or 4).

4.3.2 With the Aquarium and Buildings B and C in Place (Figure 16)

Placing the Aquarium and Buildings B and C on the site will have almost no effect on the winds at the entrances to Buildings 149 and 199, and at the west and north corners of Building 199. The squirt up the alleyway between Buildings 114 and A may be slightly increased.

The accelerated flow around the south corner of Building A will be increased, and there will be an additional area of accelerated flow around the south corner of Building C (Both probably no worse than Category 3). These two flows may cause a circular flow in front of the entrance to Building B as shown in Figure 16. The strength of this circular flow is difficult to assess, but probably will be no worse than Category 3.

Most of the east portion of the Harborwalk will be in the lee of these added buildings, and the already relatively calm winds along it will be further reduced. Only at the southern end of the Aquarium on the bridge over the drydock and near the tower at the SE end of the Rowhouses will there be significant winds (no more than Category 3).

The winds in most of the Yard's End Park will be light. The wind at the south corners of Buildings A and C and in the courtyard in front of the entrance to Building B have already been noted. There probably will also be accelerated winds at the two west corners of the Aquarium, in the narrow area between the south corner of Building C and the Aquarium, and at the north corner of the Hotel as shown in Figure 16. All areas will be in Category 3 or 4.

The winds near the tower at the NW end of the Rowhouses and at the three entrances to the Hotel will remain unchanged.

4.4 *Storm (Easterly) Winds (Figures 15 And 16)*

Easterly winds occur about one third of the time. Light easterly winds occur as a storm first starts or, in the summer, as a sea breeze. During the first 4-12 hours of a typical coastal storm, it rains or snows depending on the temperature, and the wind is generally from the NE or SE depending on whether the center of the storm passes to the east or west of the city.

Strong easterly winds generally occur when it is snowing or raining. Thus, the emphasis in the following discussions will be on entering or exiting the various buildings.

4.4.1 *Existing Conditions (Figures 17, 19, and 21)*

For NE, E, and SE winds, there will be some accelerated flow at the entrances to Buildings 149 and 199 under the pedestrian overpasses on Thirteenth Street. SE winds will cause the worst conditions (high Category 3). SE winds will also cause a squirt of wind around the east corner of Building 149 into Thirteenth Street, toward the entrances under the pedestrian overpasses (see figure 21).

Sixteenth Street between Buildings 199 and 114 and between Building 199 and Building A of the Biomedical Center will be in the lee of Buildings 114 and A for NE and E winds, but will experience accelerated flows for SE winds. Thus, the entrance to Building A under the proposed pedestrian overpass will probably be quite windy (Category 3) for SE winds.

The main entrance to Building A at its SE end will be particularly windy for both NE and E winds (high Category 3 and possibly low 2), but not as windy for SE winds. It would appear that, for most storms, one of the two entrances to Building A probably would be protected for the existing conditions.

Most of the Harborwalk will be in high Category 3 or low 2 for all these easterly winds. However, the Harborwalk near one of the two north corners of the 96-foot high addition to Building 114 will experience winds that probably exceed the BRA guideline 31 mph effective gust wind speed. While not as great, the flow in the Harborwalk near the tower at the southeast end of the Rowhouses will also be accelerated for these easterly winds (high Category 3).

The entrance to the Hotel on First Avenue will experience some windiness (low Category 3) for NE and E winds, but will be sheltered for SE winds. The entrance to the Harborwalk at the southeast end of the 135-foot high wing will also be windy for NE and E winds (High Category 3), but less windy for SE winds. The main entrance, because it is under the 30-foot high base of the 135-foot wing, will be protected from all of these easterly winds.

4.4.2 *With the Aquarium and Buildings B and C in Place (Figures 18, 20, and 22)*

The addition of the Aquarium and Buildings B and C of the Biomedical Research Center will provide considerable shelter for Buildings 199 and 149 for both NE and E winds and, thus, the winds at their entrances will probably be reduced, compared to existing conditions for NE and E winds. However, for SE winds, the additional building masses added NE and E of Building 149 and 199 will probably cause an increase of the winds at their entrances, possibly to low Category 2.

In like manner, the entrance to Building A under the pedestrian overpasses on Sixteenth Street will be less windy for NE and E winds and windier for SE winds (high Category 3).

On the other hand, the main entrances to Buildings A, B, and C into the courtyard that is part of the Yard's End Park will probably be sheltered from all easterly winds, although the south corners of Buildings A and C will probably be windy (Category 3) for both E and SE winds (see Figures 20 and 22). The possibility of a swirling flow in the courtyard in front of the main entrance to Building C is also shown in those figures. The magnitude of that swirling flow is hard to guess, but probably will be no worse than Category 3.

The exposed nature of the Harborwalk for these easterly winds combined with the presence of the taller wings of Buildings B and C will make both the north and east parts of the walk windier than for existing conditions, especially at the north corner of the 96-foot high addition to Building 114 for NE and E winds (Category 2) and at the northeast corner of Building B for all easterly winds (Category 2). The addition of the Aquarium will result in the bridge across the SE end of Dry Dock 5 having increased winds for all easterly winds (low Category 2). Wind conditions on the Harborwalk near the tower at the southeast end of the Rowhouses will remain the same or be slightly reduced for these easterly winds.

The addition of the Aquarium and Buildings B and C will provide considerable shelter for the part of Yard's End Park surrounded by these buildings and the Hotel for all easterly winds. There will be some accelerated flow at the south corners of Buildings B and C and in the necked down area between Building C and the Aquarium, but these are not areas where pedestrians will want to go on stormy days. The main entrance to the Aquarium is sheltered from all easterly winds.

Finally, the winds at the main entrance to the Hotel will remain calm, and those at the other two entrances will be reduced. There will be an area of accelerated flow in the narrow passage between the Hotel and the Aquarium for both NE and SE winds (see Figures 18 and 22).

5.0 SUMMARY

An assessment of the effects of adding the new New England Aquarium and Buildings B and C of the proposed Biomedical Research Center to the Charlestown Navy Yard complex has been made. Existing conditions are depicted in Figure 1, and proposed conditions in Figure 2. Winds at the entrances to existing buildings (149, 199, A, and the Hotel) are improved for most wind directions, and where they are not improved, the expected increases are small.

Wind conditions at the main entrances to Buildings A, B, and C of the Biomedical Research Center are expected to be acceptable. Those at the entrance to Building A are much improved by the addition of Buildings B and C. Wind conditions at the main entrance to the Aquarium are also acceptable for all winds.

Wind conditions in Yard's End Park at the SE end where most pedestrian traffic is expected are also much improved for build conditions.

However, expected winds along the north part of the Harborwalk are made worse by the presence of the higher wings of Building B for build conditions, particularly at the NE corner of the walk. While wind conditions over the rest of the Harborwalk will still be windy at times, this is primarily a result of the exposed nature of the Harborwalk.

6.0 MITIGATION

Wind conditions along the north portion of the Harborwalk for build conditions could be improved in the following way: the first two or three stories of the base of Buildings B and C could be left open for a depth of 20 to 30 feet next to the Harborwalk. The proposed use of these lower stories for a parking garage conforms to this qualitative recommendation, especially if those outside walls are left as open as possible. This is the likely design since the garage is not planned to be mechanically ventilated.

It is interesting to note that, while the winds at the entrances of Buildings A, B and C are probably much reduced due to the change from the original to the current massing of the Biomedical Center, those along the Harborwalk are only slightly reduced, but those are essentially unavoidable given the natural exposures.

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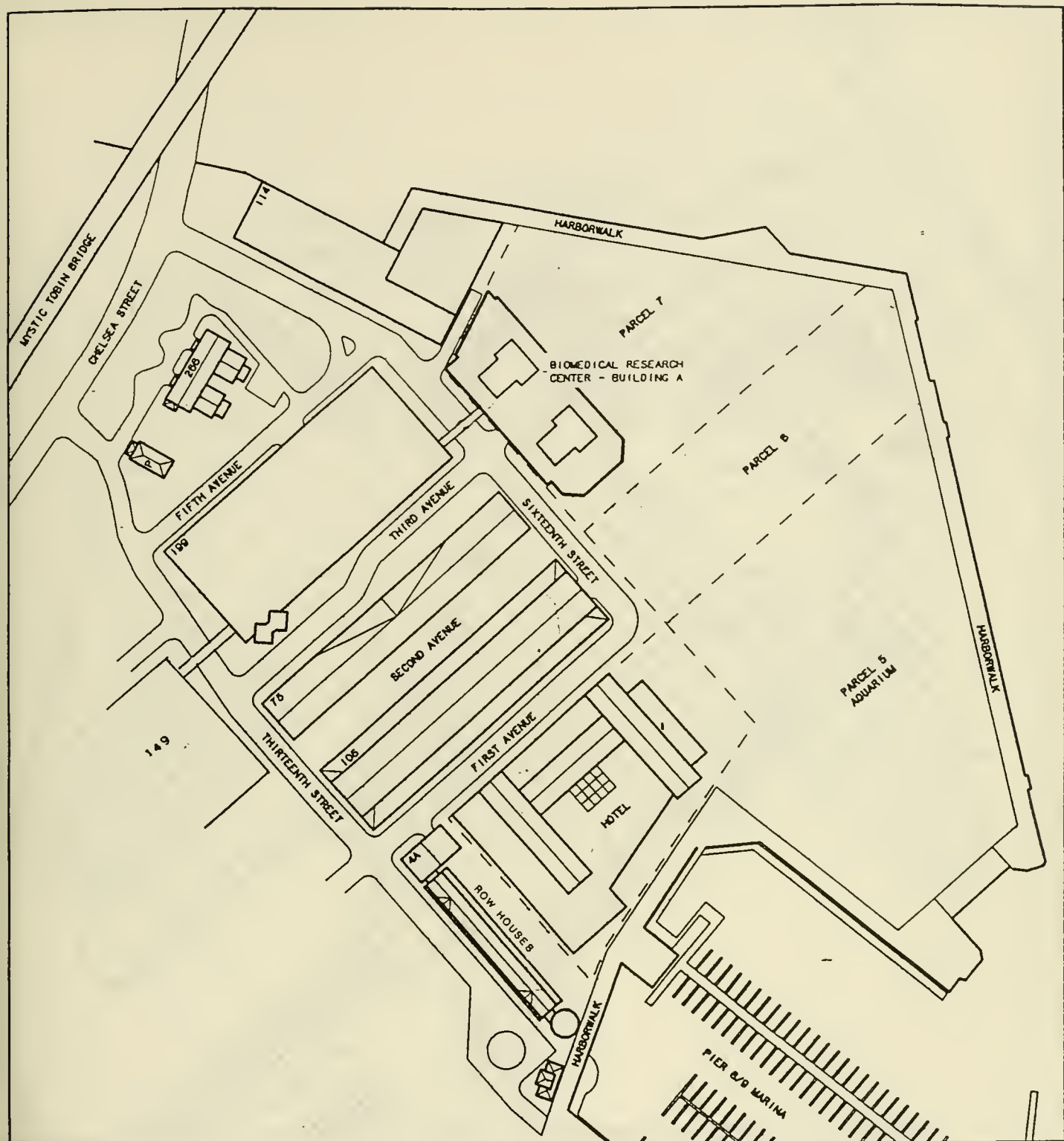


Figure 1 Existing Conditions



Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

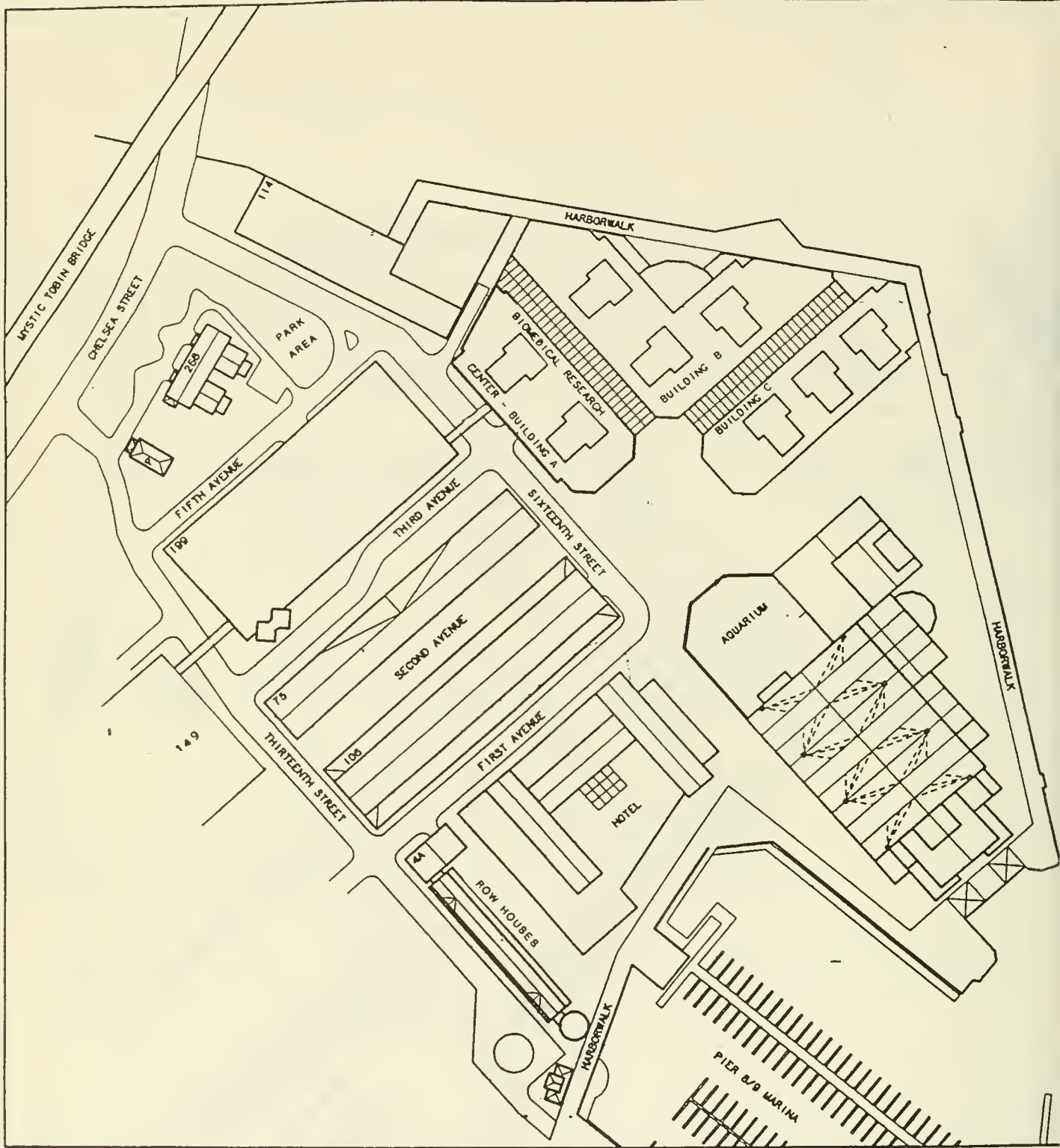


Figure 2

Proposed Conditions

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

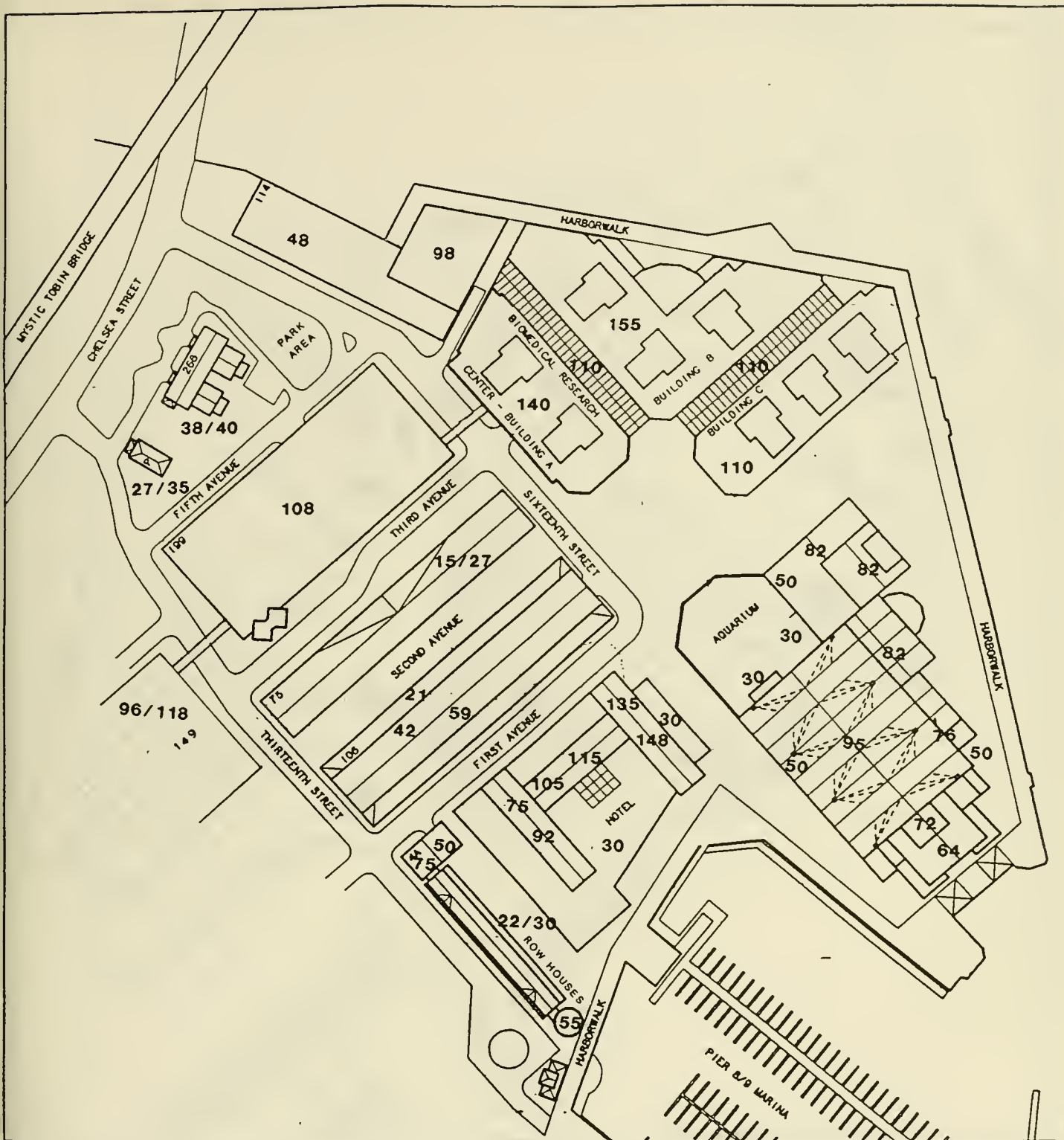


Figure 3 Proposed Conditions Building Heights

Charlestown Navy Yard
 Biomedical Research Center
 Buildings B and C, and
 New England Aquarium
 Wind Assessment
 Prepared By: Frank H. Durgin, P.E.

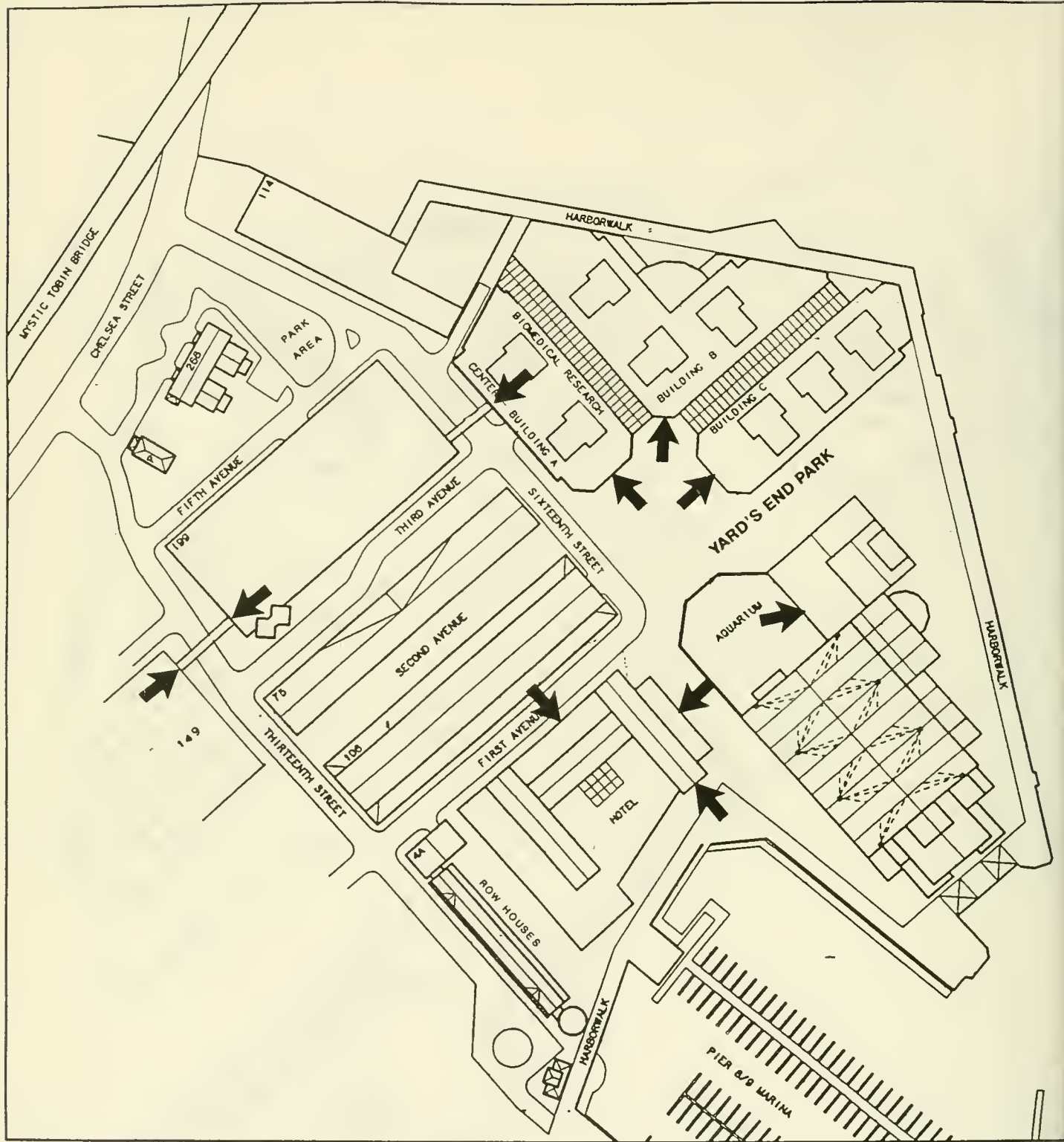
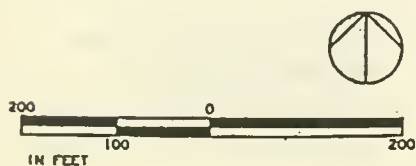


Figure 4

Proposed Conditions Building Entrances



← Building Entrances

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

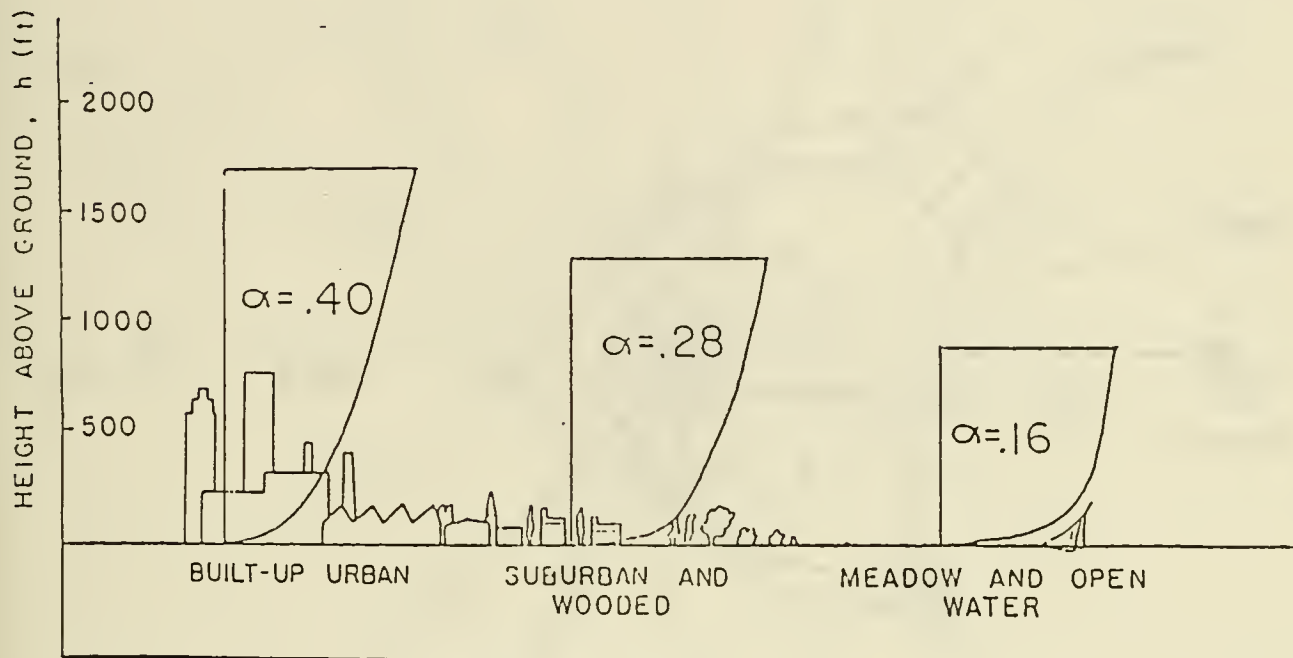


Figure 5

Types Of Earth's Boundary Layer — — Davenport

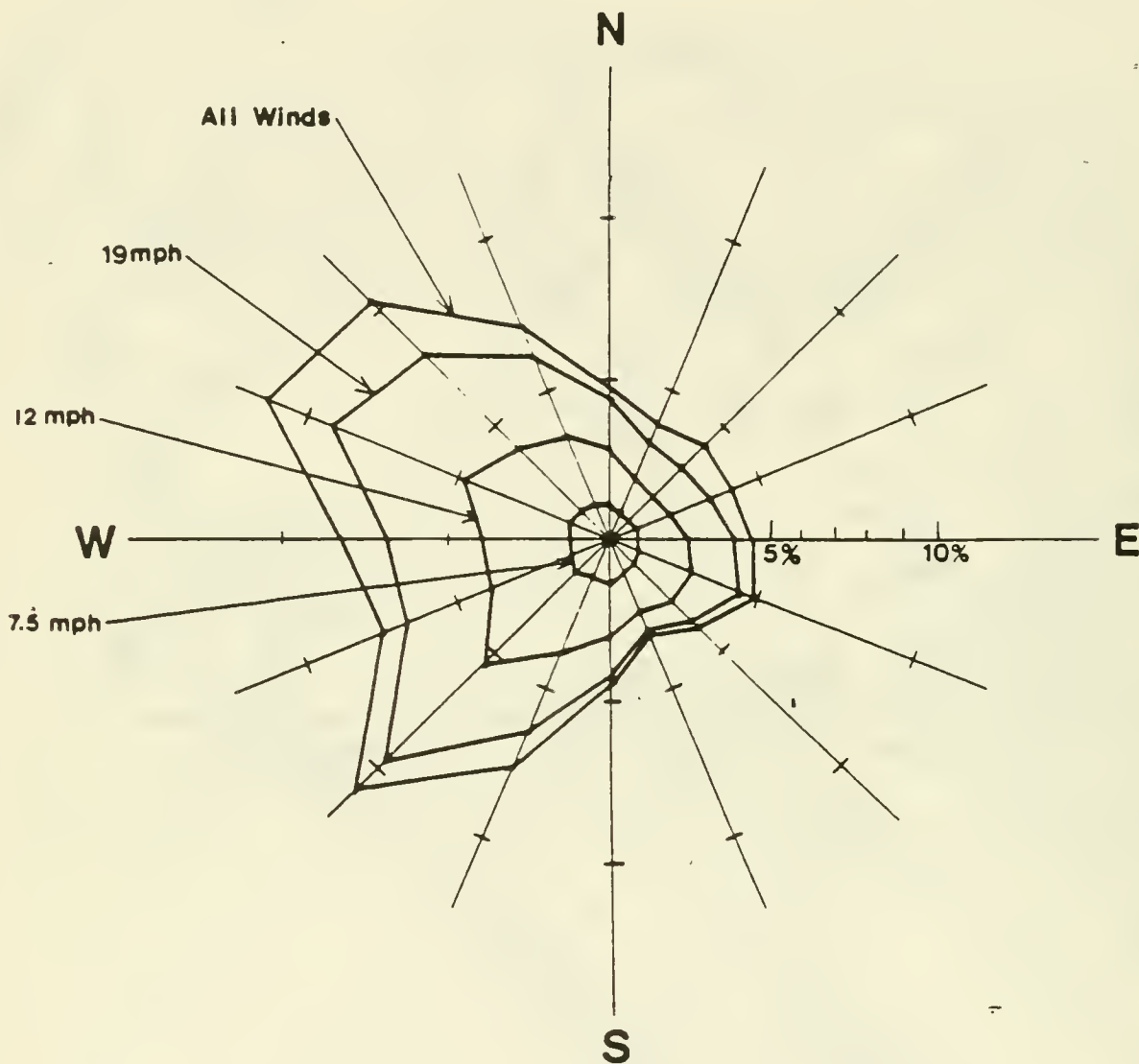


Figure 6

Boston Wind Rose For The Year

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

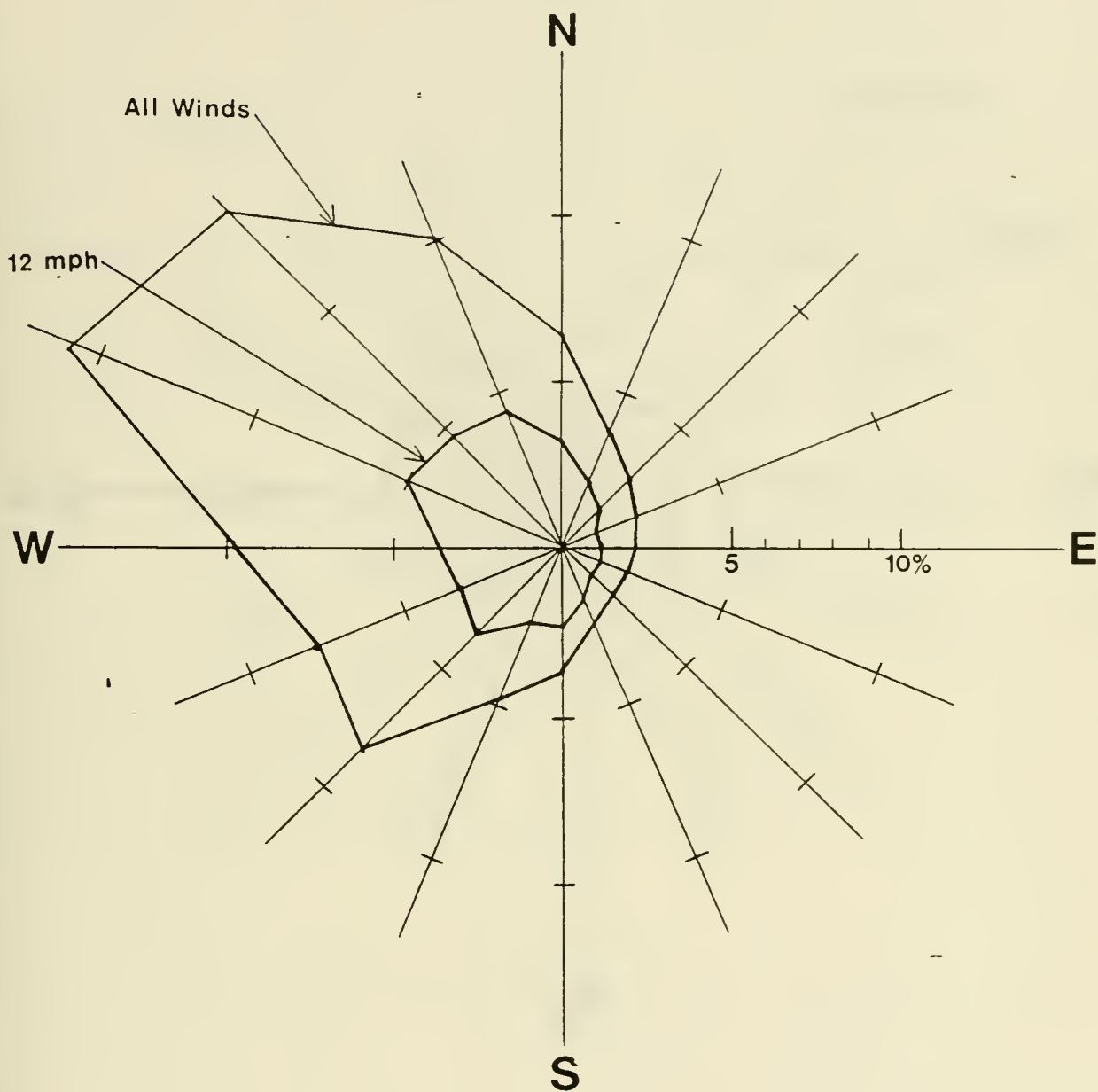


Figure 7

Boston Wind Rose For The Winter (December, January, February)

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

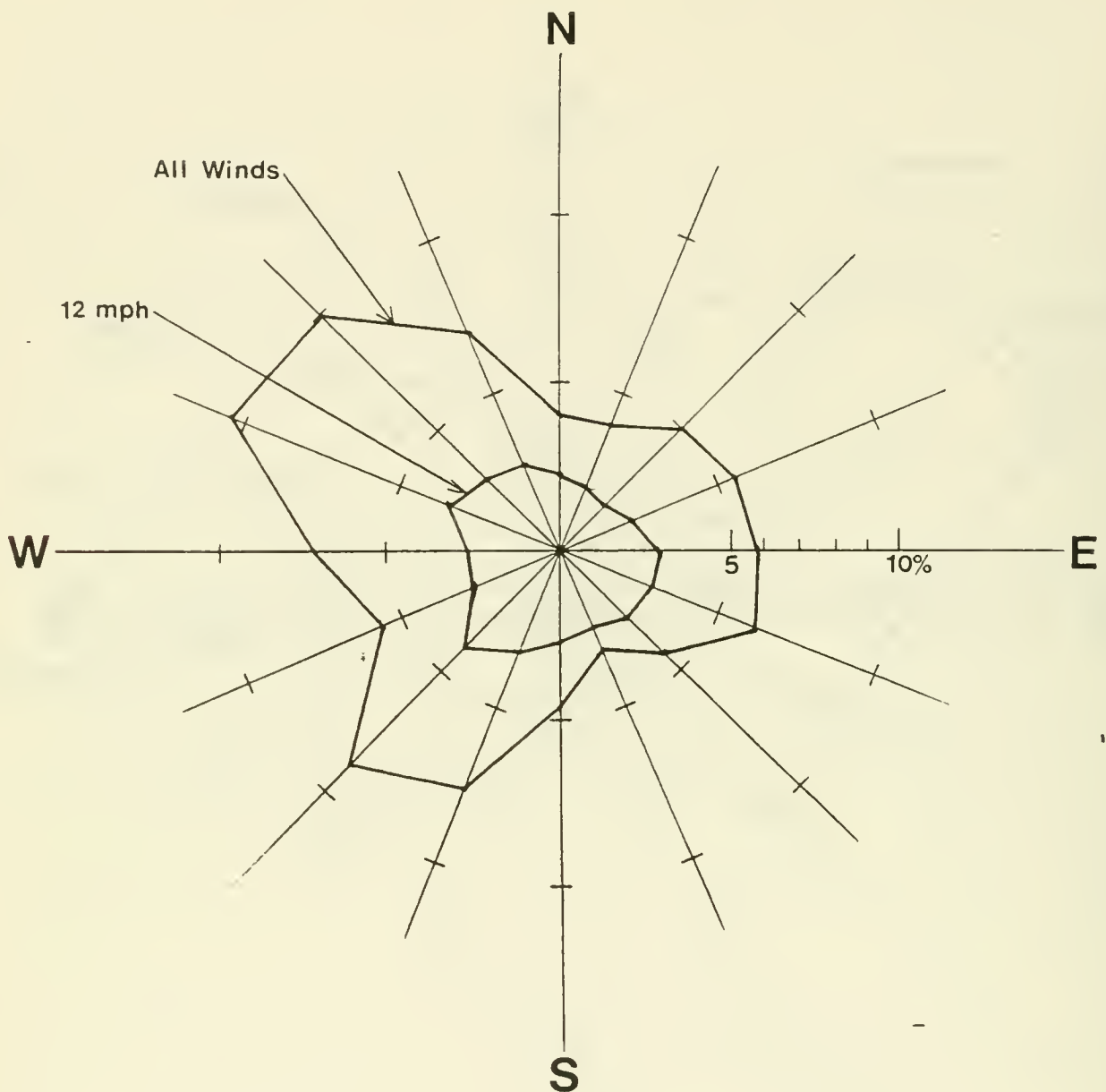


Figure 8

Boston Wind Rose For The Spring (March, April, May)

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

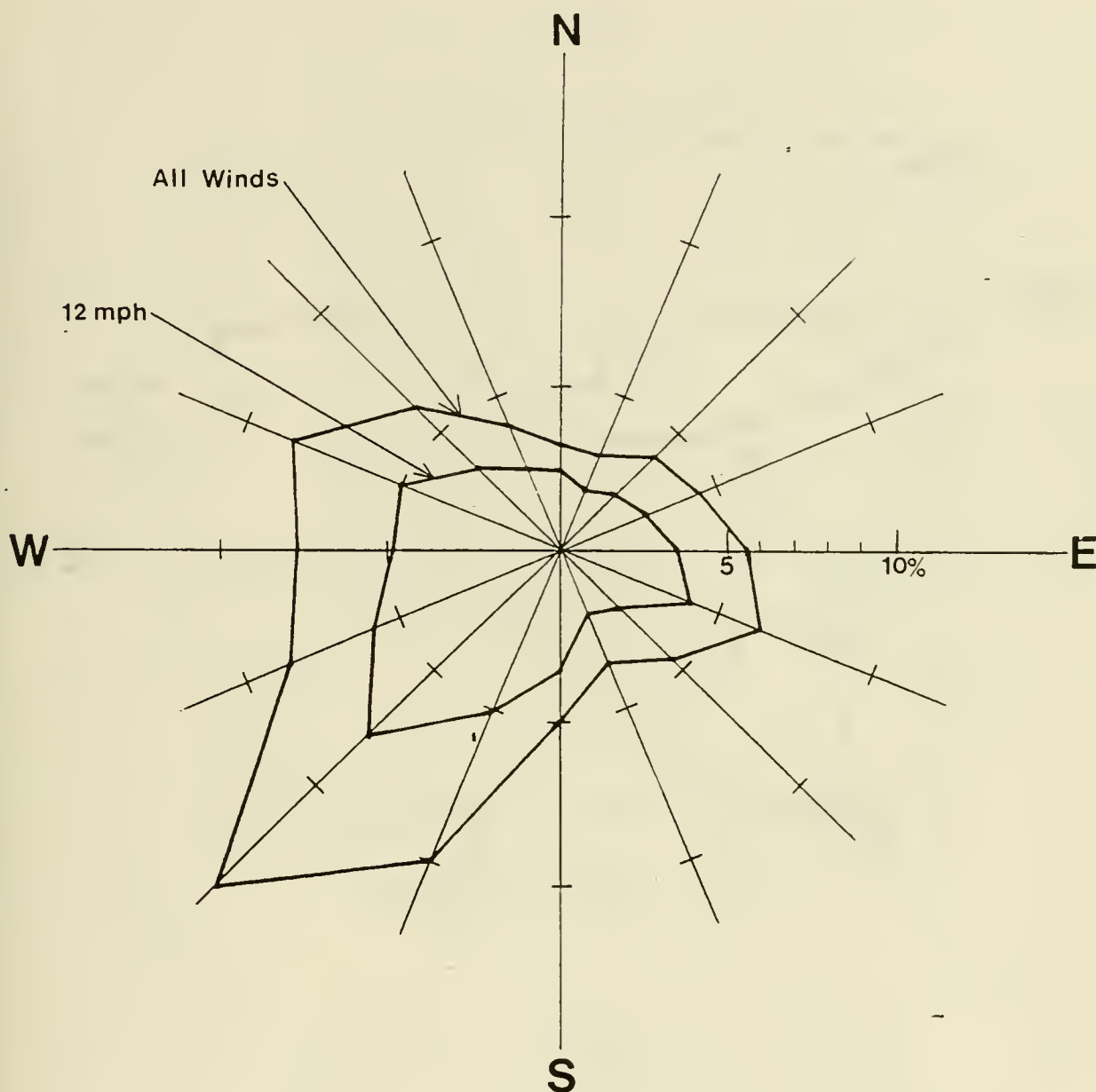


Figure 9

Boston Wind Rose For The Summer (June, July, August)

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

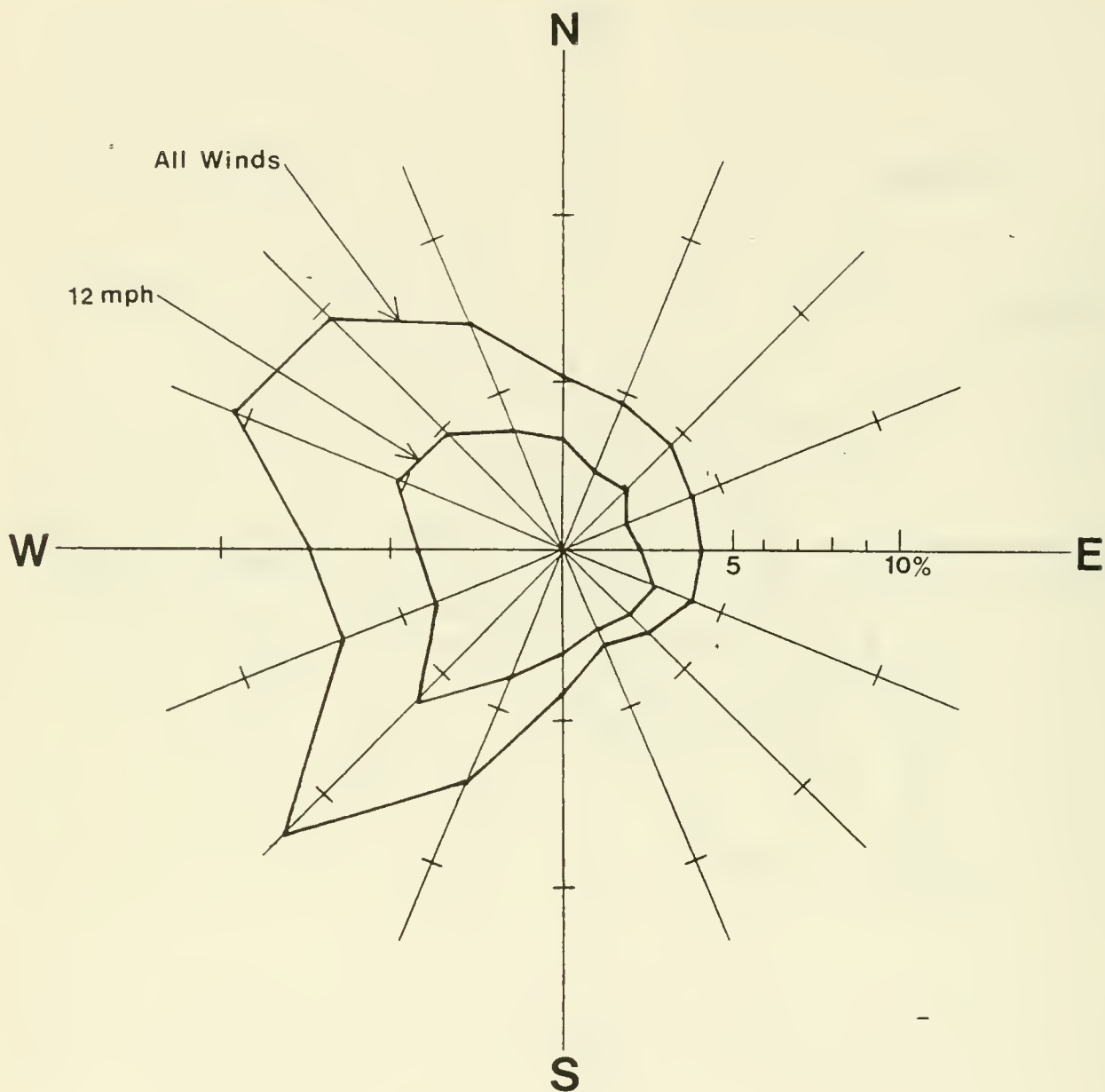


Figure 10

Boston Wind Rose For The Fall (September, October, November)

Surface Data Obtained From Logan Airport 1945-1965

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

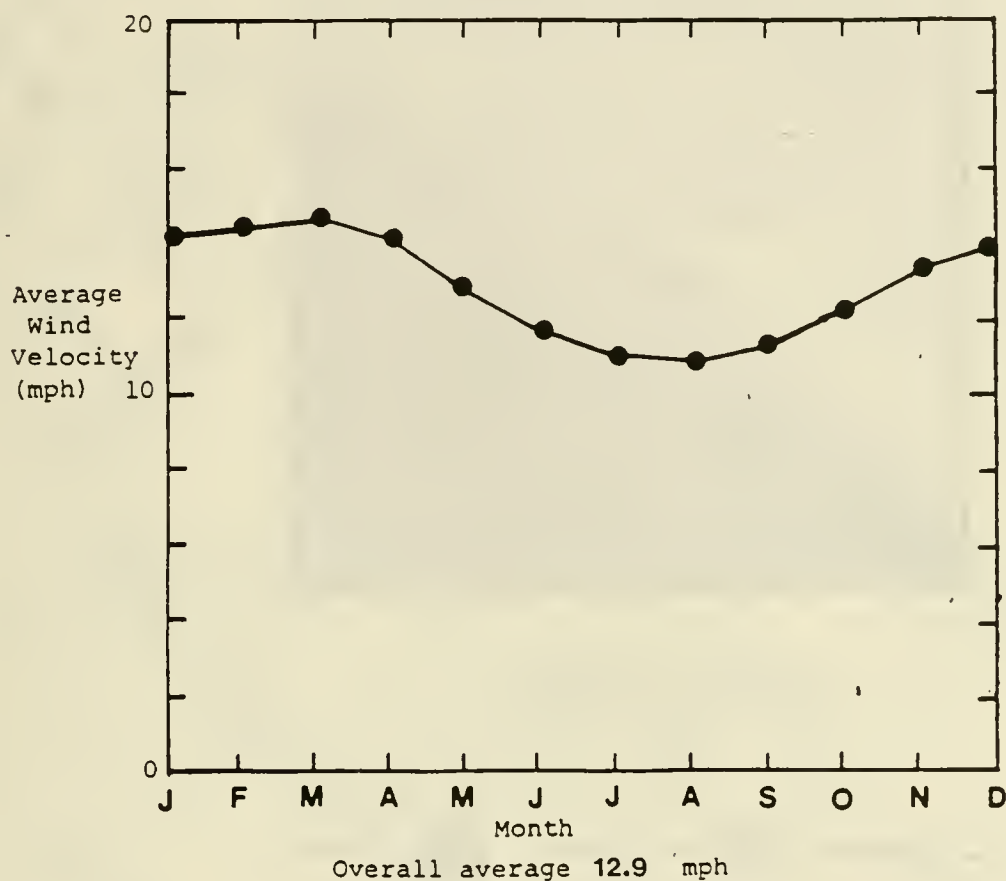
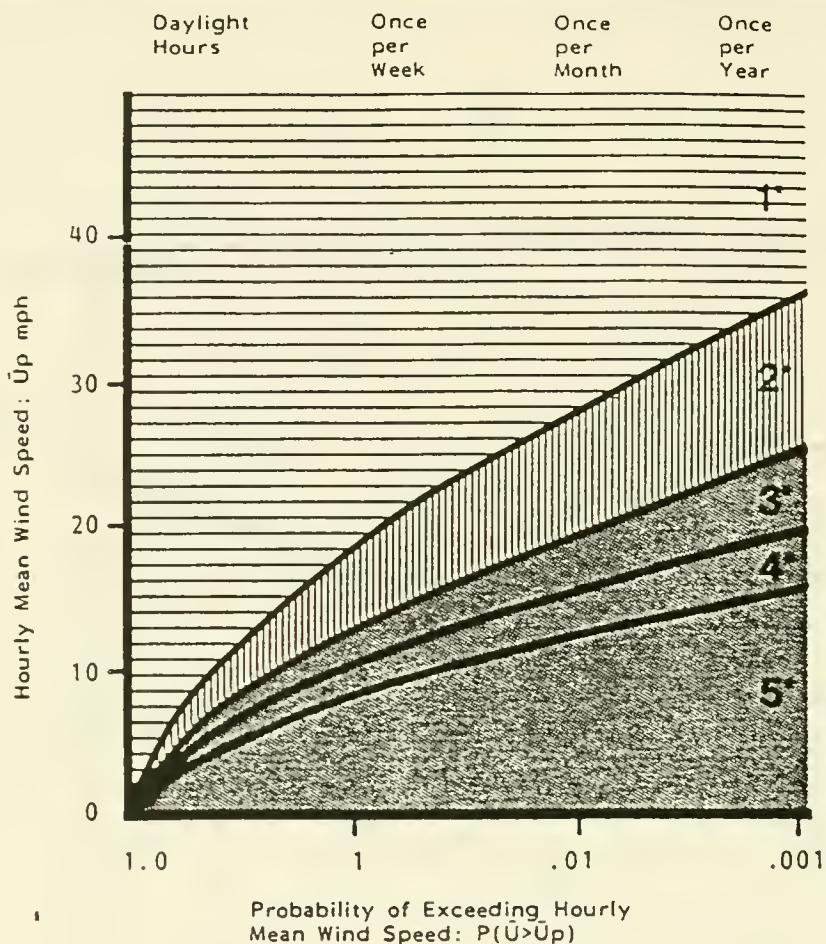


Figure 11

Average Wind Velocity At Logan Airport At 58 ft, 1945-1965, By Month



Dangerous
 Uncomfortable
 Comfortable

* Melbourne's Category

- 1 Unacceptable and dangerous
- 2 Uncomfortable for walking
- 3 Acceptable for walking
- 4 Acceptable for short periods of standing or sitting
- 5 Acceptable for long periods of standing or sitting

Figure 12

Melbourne's Category

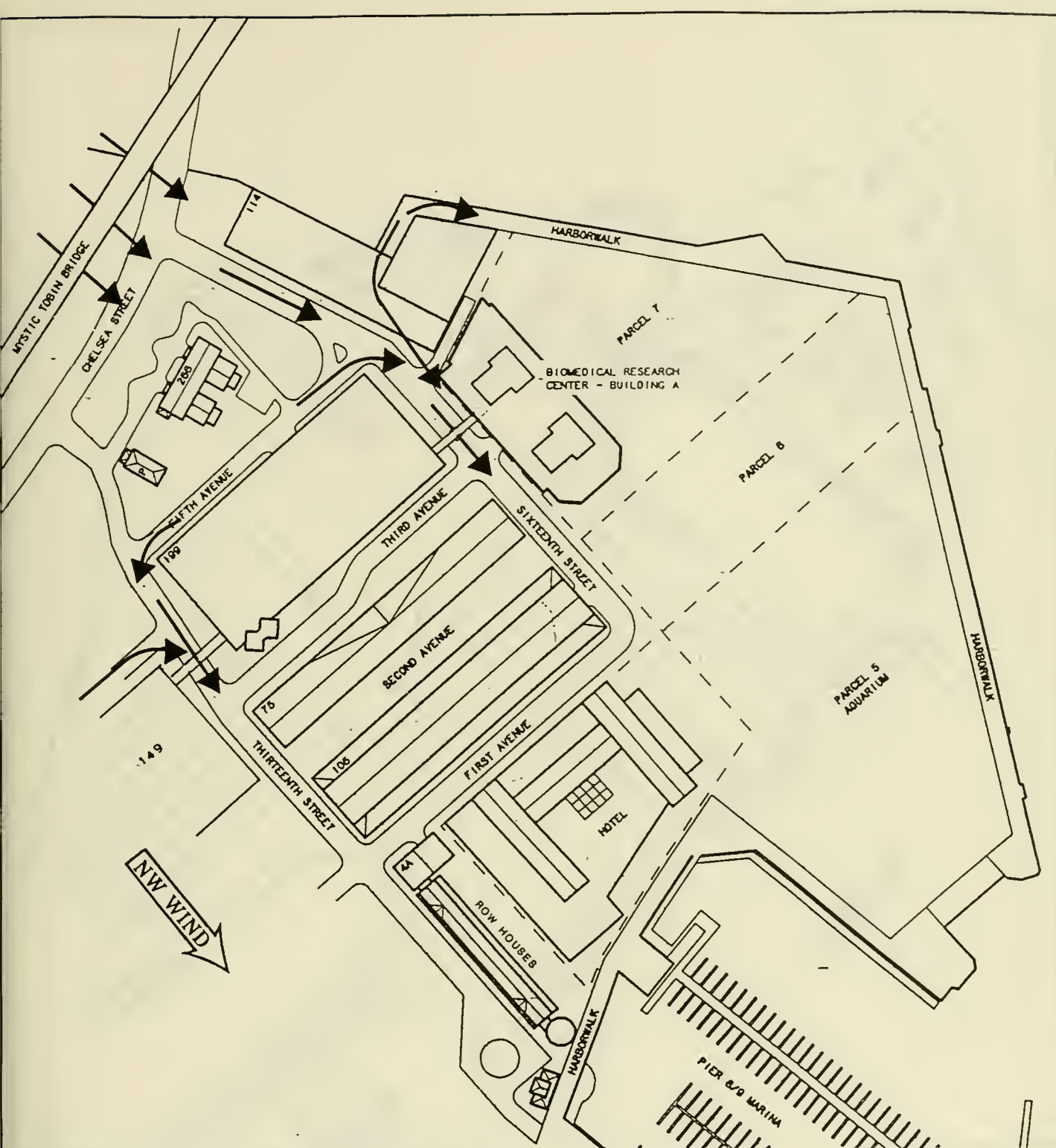
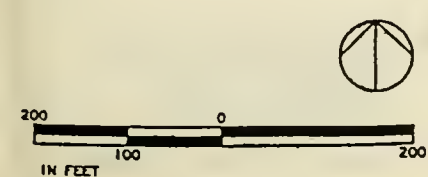


Figure 13 Existing Condition Wind Flow Patterns - Winds From Northwest



← Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

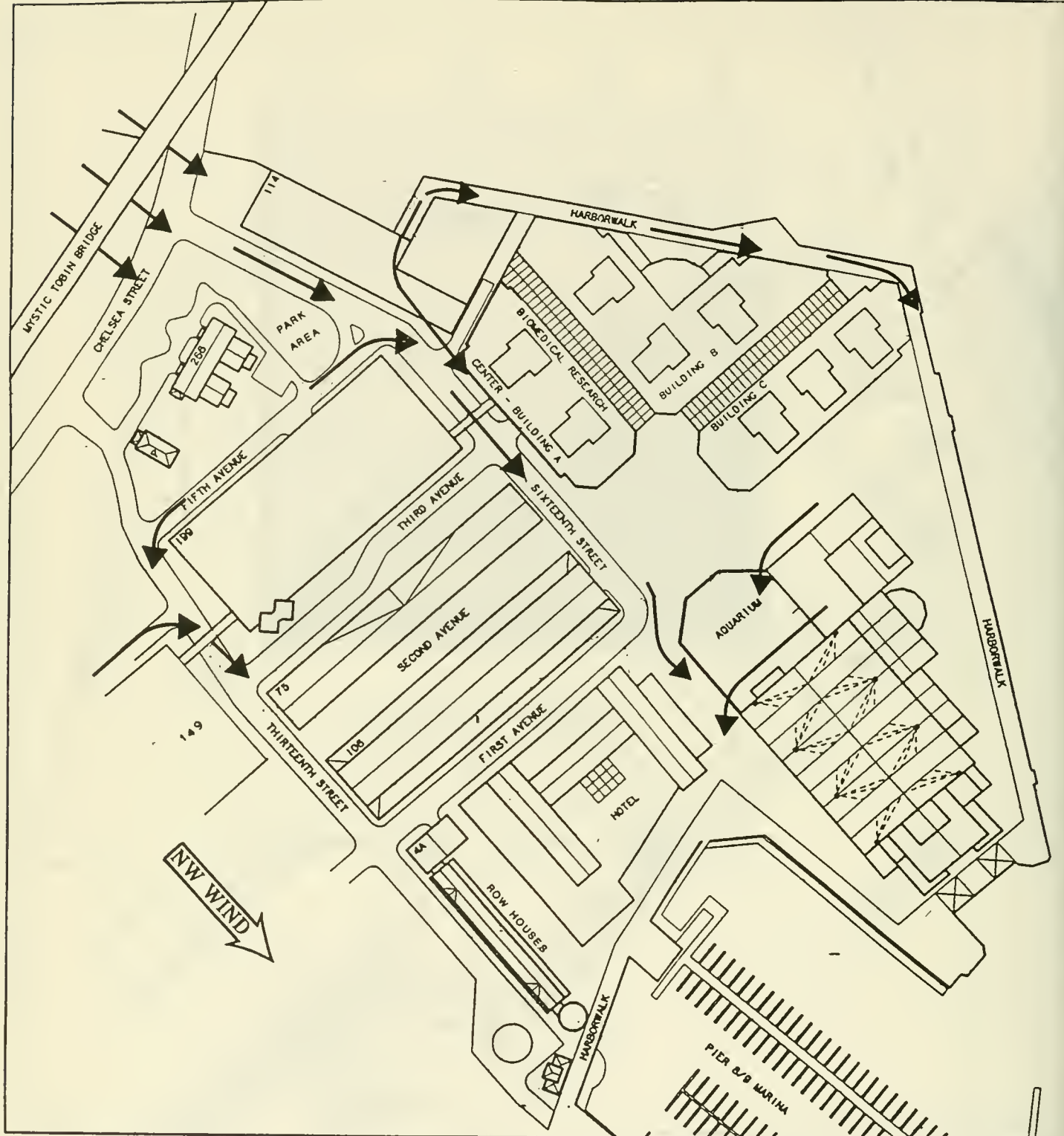
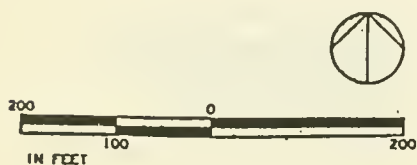


Figure 14

Proposed Condition Wind Flow Patterns - Wind From Northwest



← Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

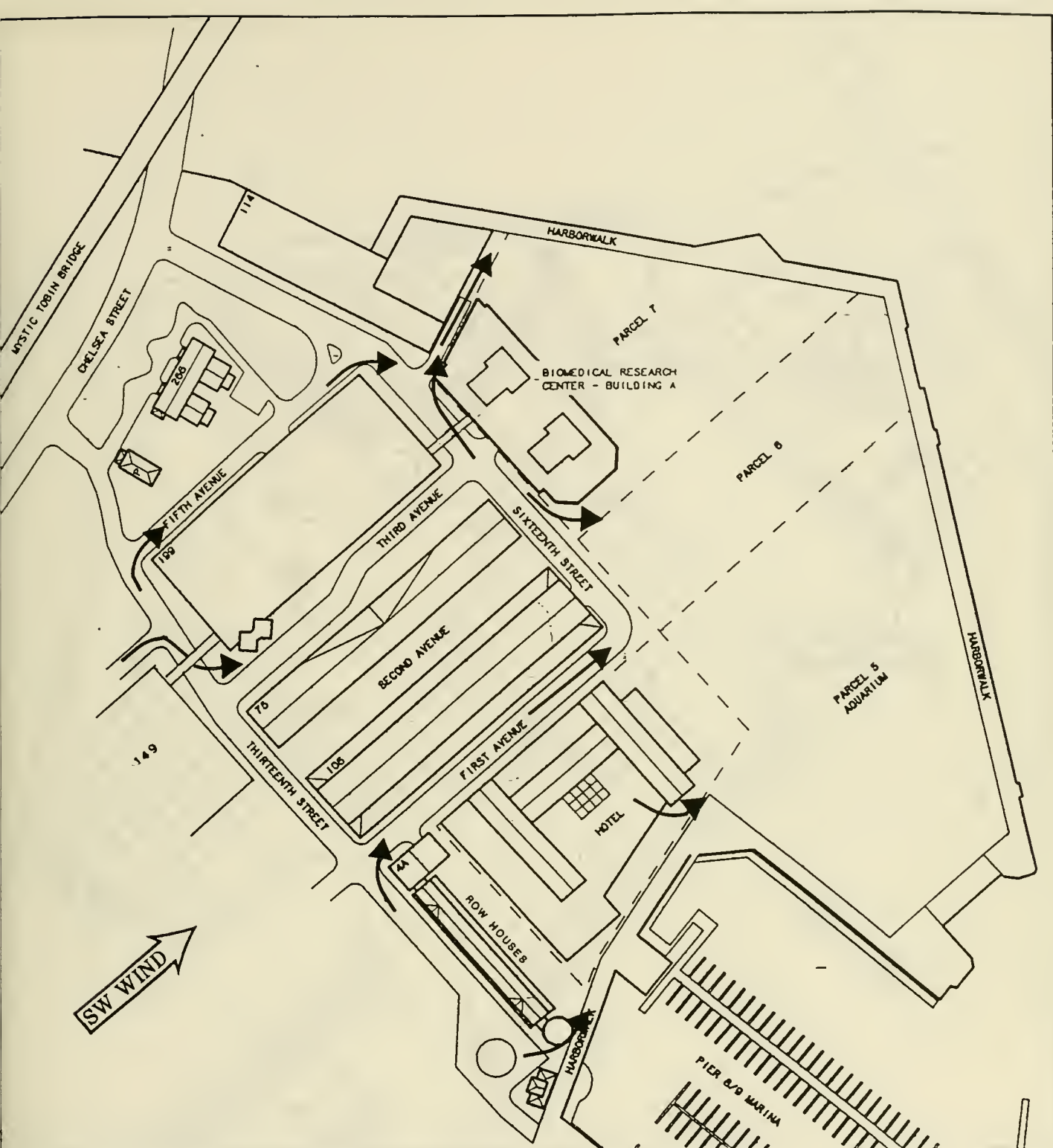
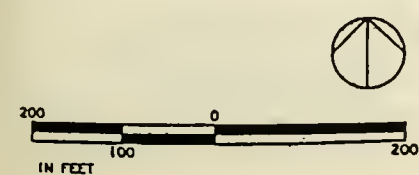


Figure 15 Existing Condition Wind Flow Patterns - Wind From Southwest



← Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

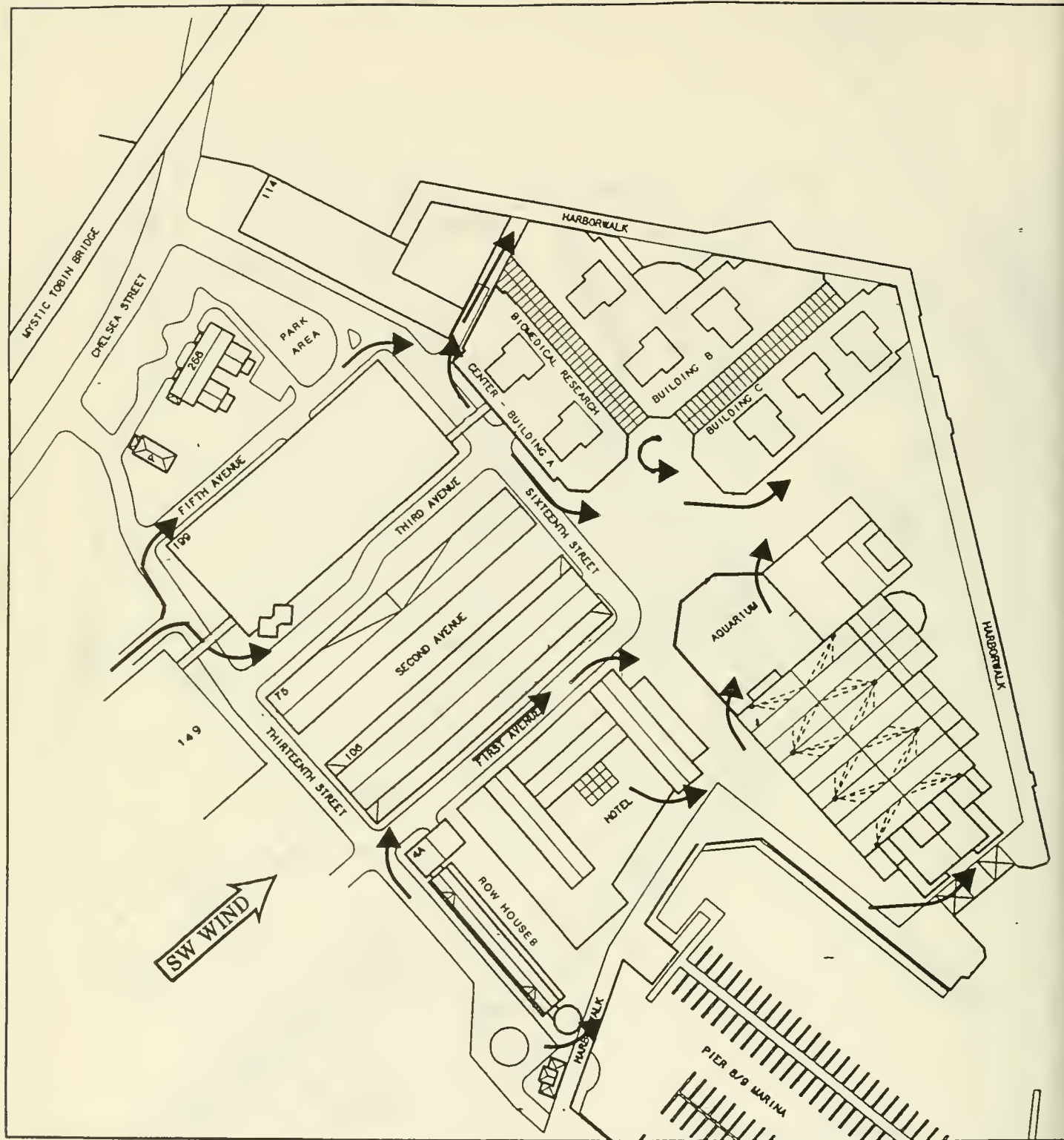


Figure 16

Proposed Condition Wind Flow Patterns - Wind From Southwest

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

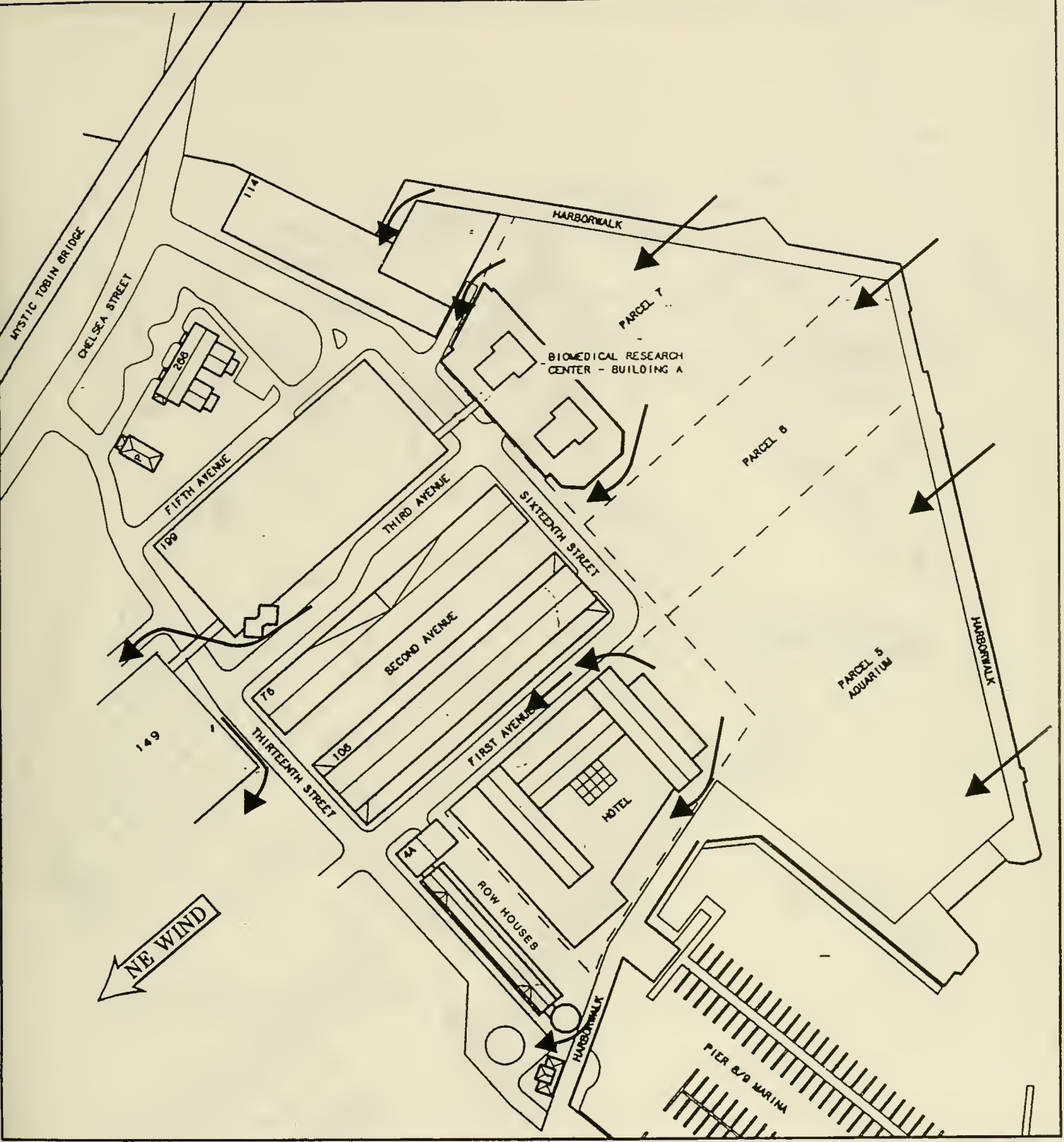


Figure 17 Existing Condition Wind Flow Patterns - Wind From Northeast

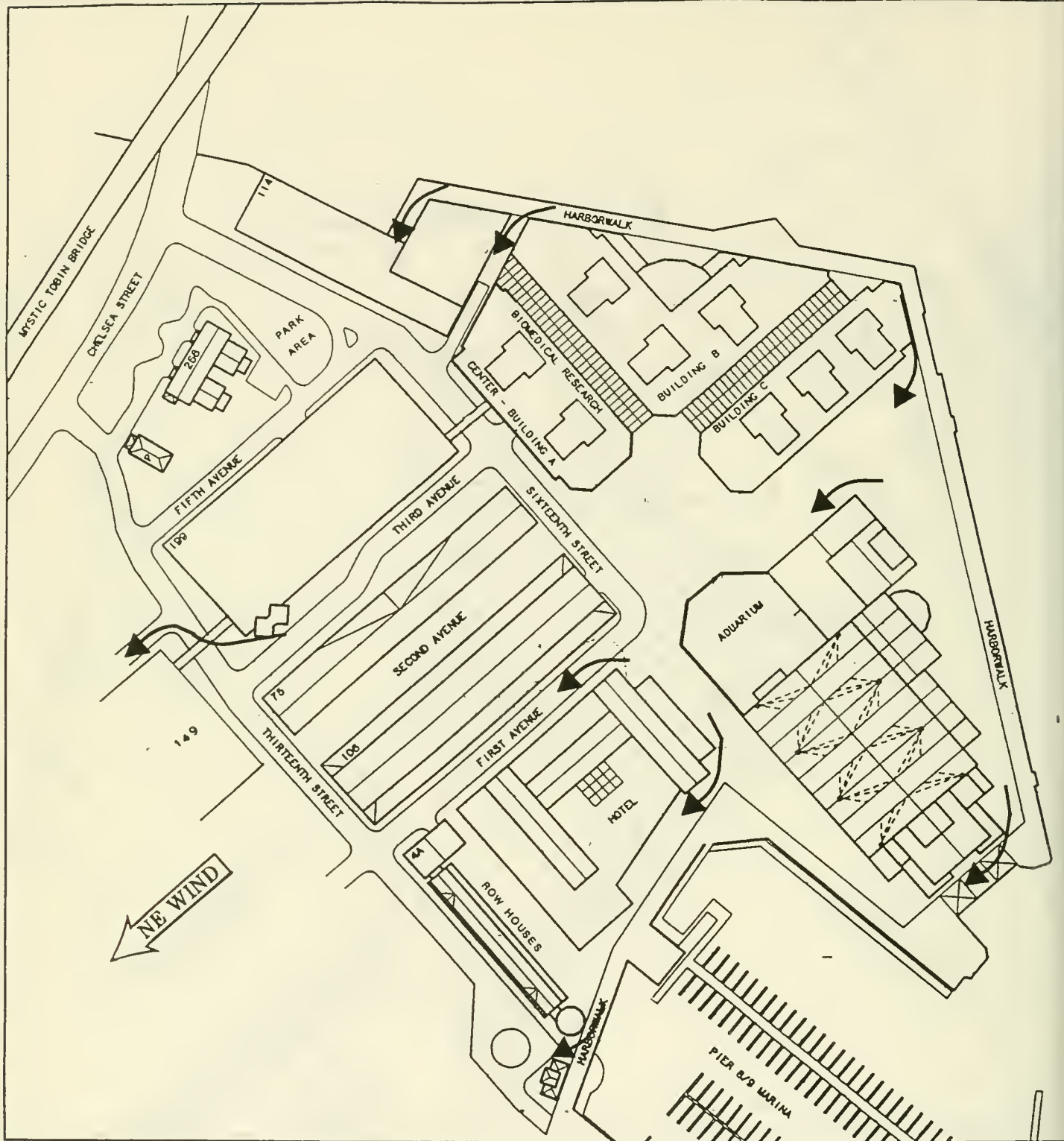
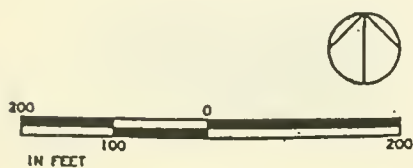


Figure 18

Proposed Condition Wind Flow Patterns - Wind From Northeast



← Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

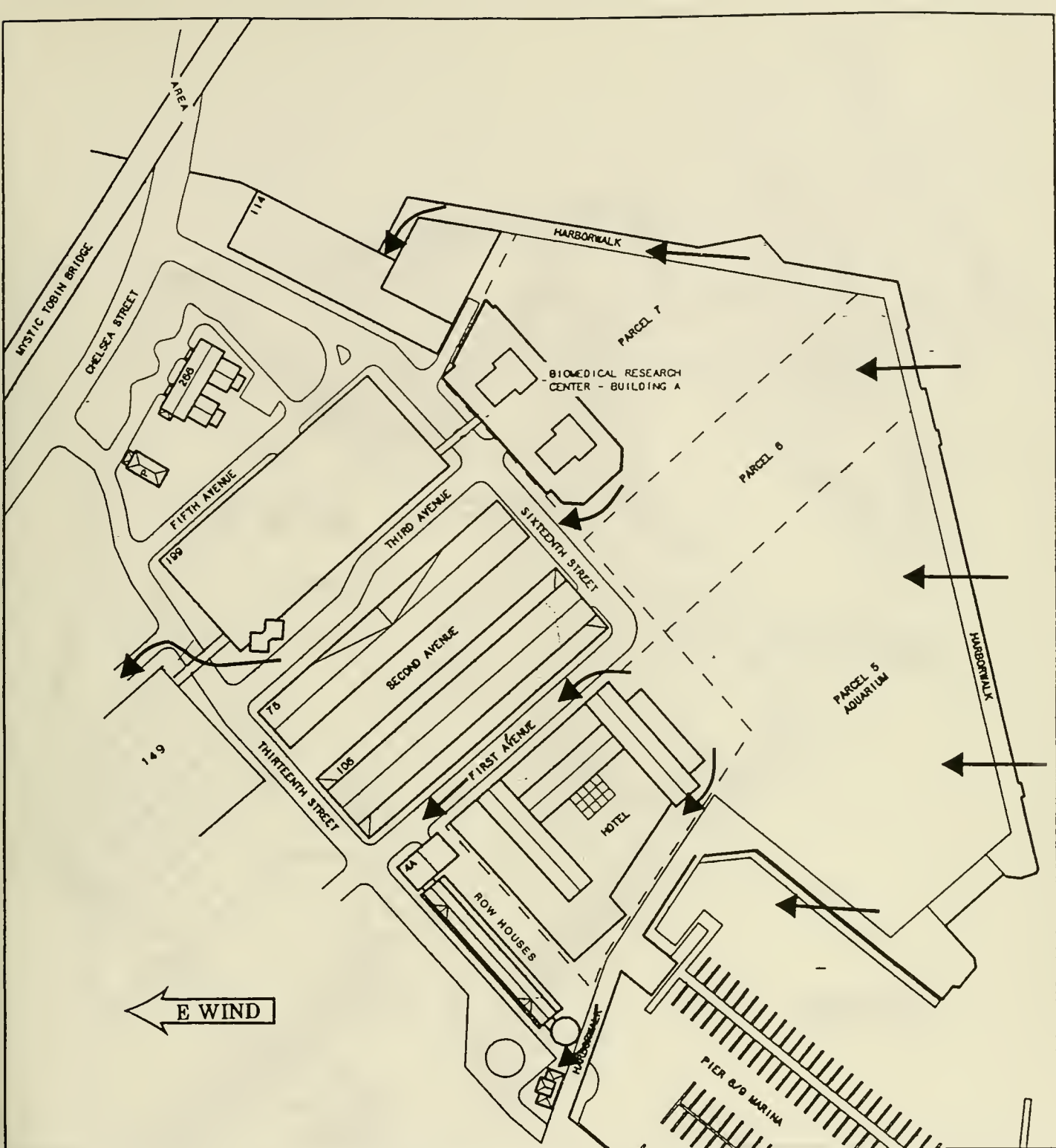
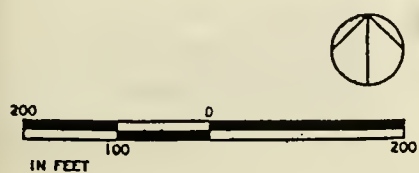


Figure 19 Existing Condition Wind Flow Patterns - Wind From East



Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

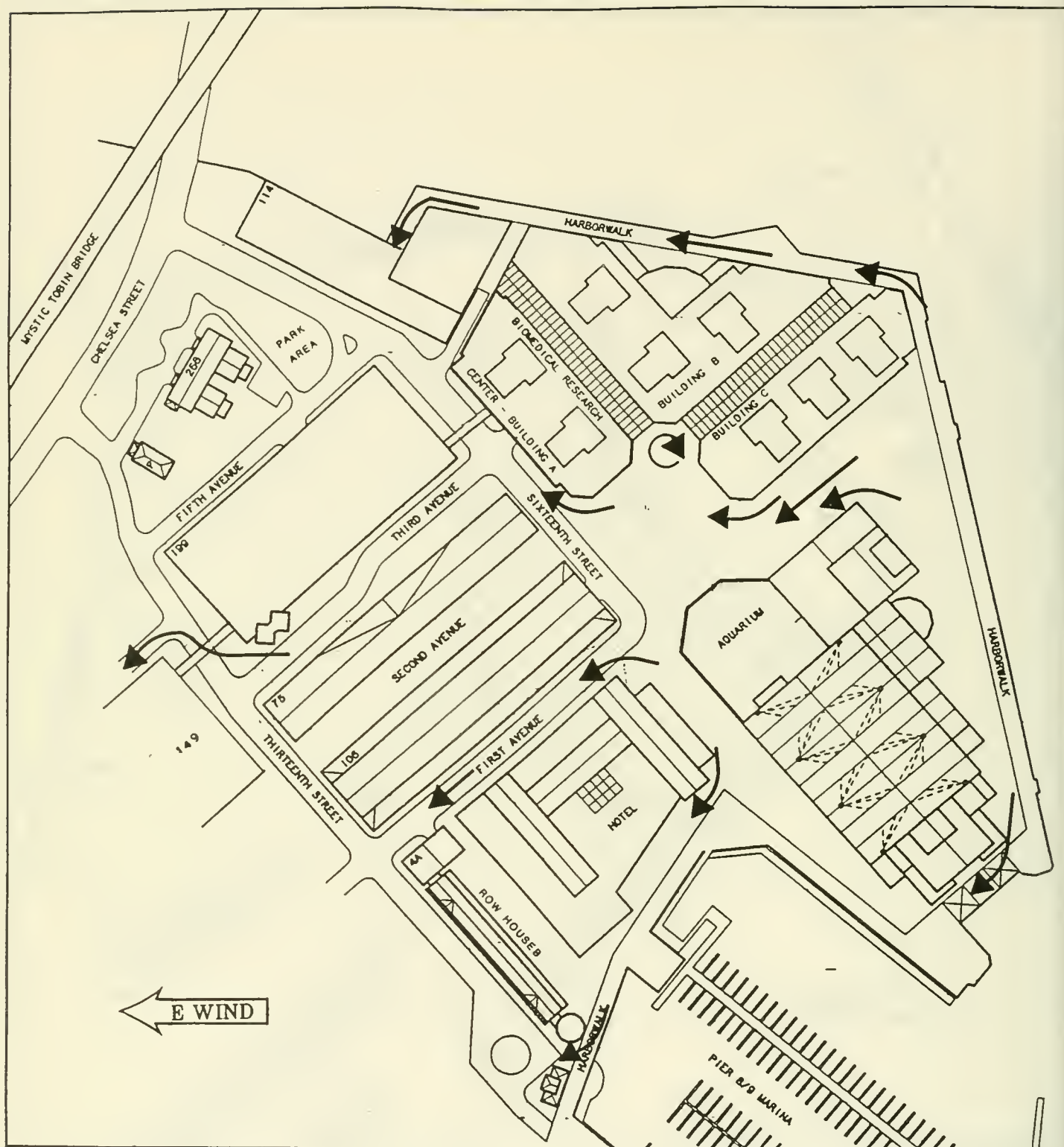


Figure 20 Proposed Condition Wind Flow Patterns - Wind From East



← Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

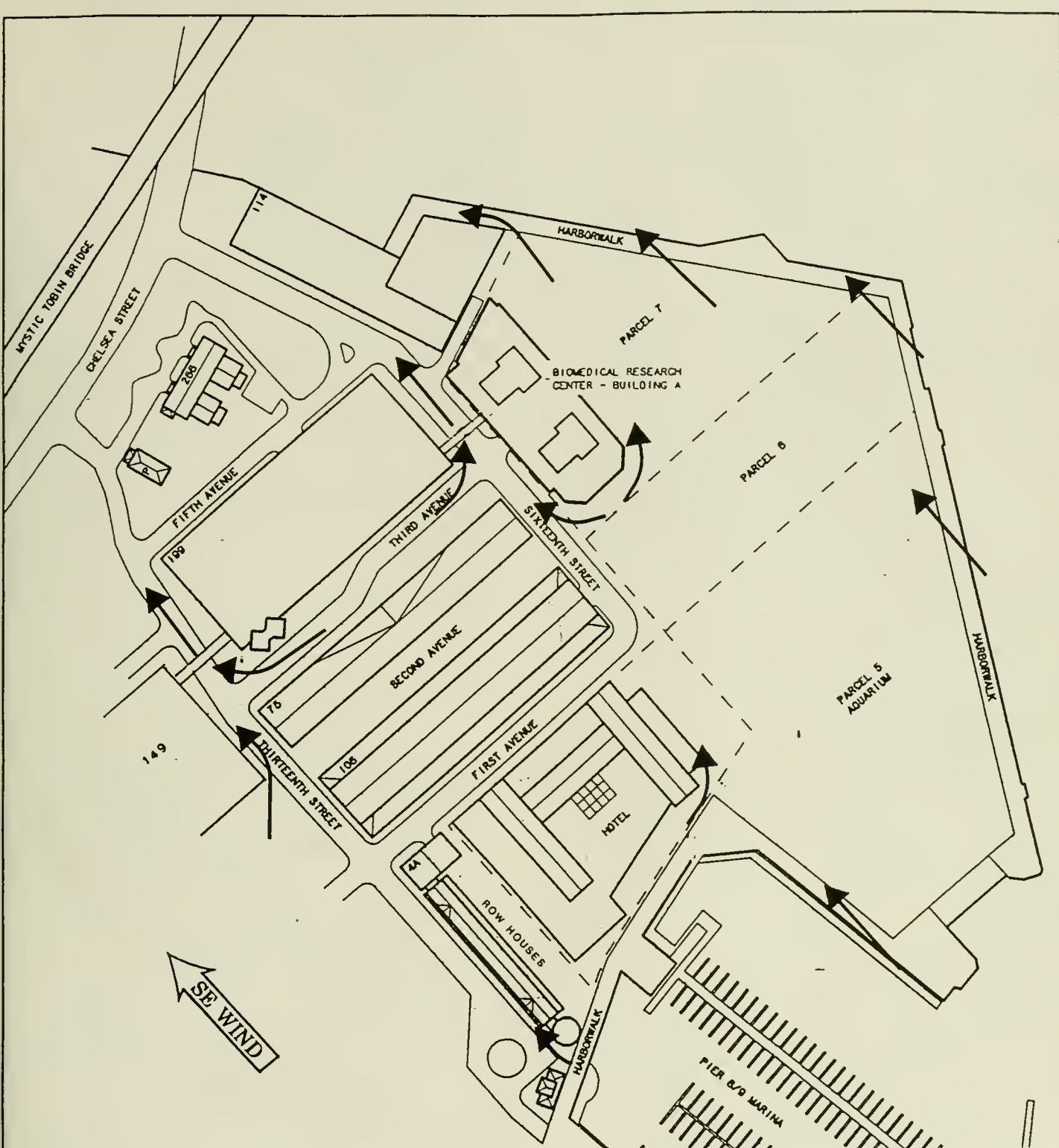


Figure 21 Existing Condition Wind Flow Patterns - Wind From Southeast



← Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

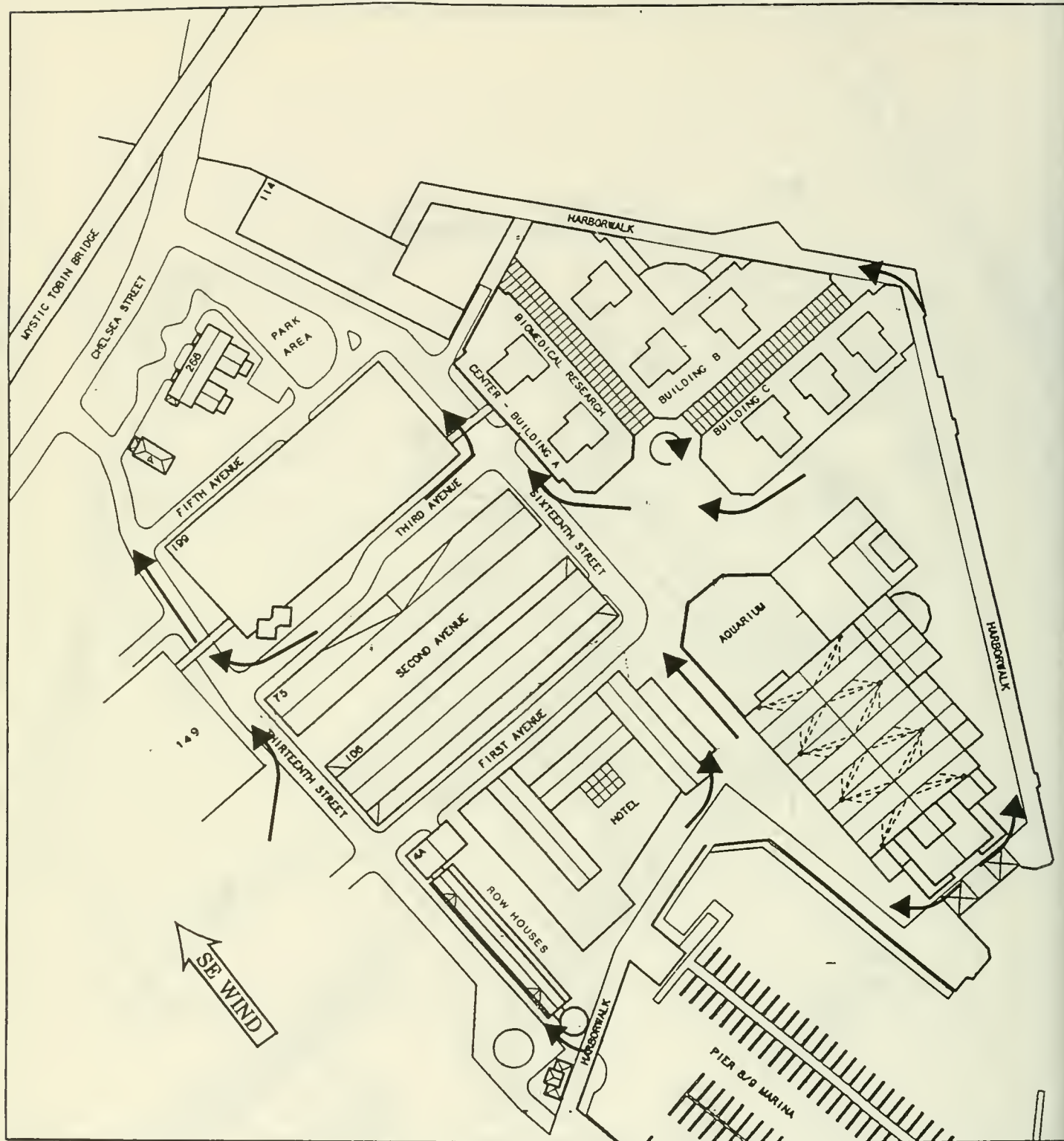
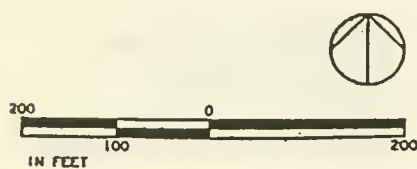


Figure 22

Proposed Condition Wind Flow Patterns - Wind From Southeast



← Local Wind Direction

Charlestown Navy Yard
Biomedical Research Center
Buildings B and C, and
New England Aquarium
Wind Assessment
Prepared By: Frank H. Durgin, P.E.

APPENDIX G
SHADOW ANALYSIS

APPENDIX G1

BUILDING A OF THE BIOMEDICAL RESEARCH CENTER

gov 91-2302

CHARLESTOWN NAVY YARD

BIOMEDICAL RESEARCH CENTER - BUILDING A

SHADOW ANALYSIS

Prepared for: Boston Redevelopment Authority

Prepared by: Sasaki Associates, Inc.

Date: August 20, 1991

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| Conclusions | 4 |
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19. Existing Conditions Shadow Analysis, December 21/9:00 a.m.
20. Proposed Conditions Shadow Analysis, December 21/9:00 a.m.
21. Existing Conditions Shadow Analysis, December 21/12 noon
22. Proposed Conditions Shadow Analysis, December 21/12 noon
23. Existing Conditions Shadow Analysis, December 21/3:00 p.m.
24. Proposed Conditions Shadow Analysis, December 21/3:00 p.m.

INTRODUCTION

This study addresses existing conditions and the shadow impacts produced by the proposed Biomedical Research Center - Building A on pedestrian open space areas in the vicinity of the site. The open space areas of concern include the proposed Harborwalk, the proposed Yard's End Park at the New England Aquarium site, and the pedestrian walkways along Second Avenue and Sixteenth Street.

EXISTING AND PROPOSED CONDITIONS

Current land uses in the area that will be subject to shadows cast by Building A are primarily vacant land parcels, or vacant industrial buildings characterized by low rise, large-footprint, warehouse-type buildings. The only existing occupied building that will be affected by shadows cast from Building A is Building 199, which currently functions as a parking garage. Existing uses and open space areas in the vicinity of the site, because of their vacant condition, will not be adversely impacted by shadows cast from Building A.

The proposed project is part of the Charlestown Navy Yard Redevelopment Plan. Future uses and pedestrian areas planned for the immediate area include the following:

Proposed Uses

- Biomedical Research Center Phases B and C consisting of two buildings and located north and east of Building A on Parcels 7 and 6.
- The New England Aquarium at Drydock 5 located southeast of Building A on Parcel 5.
- A 400-suite hotel located on Parcel 4 and south of Building A.
- A public parking garage to be built within the shell of the existing Building 114.

Proposed Pedestrian Areas

- Harborwalk - a continuous pedestrian thoroughfare along the waterfront providing a pedestrian link between the USS Constitution and the Aquarium and other Navy Yard uses. A portion of the Harborwalk is located to the north of Building A and is separated from Building A by the proposed Biomedical Research Center Phases B and C.
- Yard's End Park - a park space and plaza located between the Aquarium and Building A, at the end of First Avenue on Parcels 5 and 6.
- A park located west of the intersection of Fifth Avenue and Sixteenth Street.
- Sixteenth Street - a secondary auto and pedestrian thoroughfare.

- Second Avenue - a major pedestrian axis for the Navy Yard Redevelopment area, starting at Fifth Street and extending to the Biomedical Research Center and Yard's End Park.

METHODOLOGY

Shadows were projected for Building A on four (4) key days of the year: March 21, June 21, September 21, and December 21 to establish a representative view of shadow impacts through the four seasons. Morning (9 AM), noon (12 PM), and afternoon (3 PM) shadows were calculated in order to understand the movement of shadows throughout each day.

Solar time was used to calculate the altitude and azimuth of the sun for each time, using geographical data about Charlestown (42°-23' N latitude, 71°-03' W longitude), the day length effects of the elliptical nature of the earth's rotation around the sun, and Daylight Savings Time. These factors result in solar time that can differ from clock time by thirty minutes or more. Daylight Savings Time was taken into account for June and September shadow calculations.

Graphics were prepared to show (1) existing condition shadows and (2) shadows of the Proposed Project, and are intended to give a general understanding of shadow impact areas (See Figures 1 to 24).

ANALYSIS OF IMPACTS

March 21: March 21 is the Vernal Equinox, the mid-point in the year when day and night are equivalent in length.

March 21/9:00 AM (EST). (See Figures 1 and 2.)

Shadows from Building A will be cast on a portion of the northeastern half of Sixteenth Street. A 30 foot segment of the Harborwalk just north of Building 114 will be in shadow at this hour.

March 21/12:00 Noon (EST). (See Figures 3 and 4.)

A 30 foot segment of the Harborwalk north of Building A will be in shadow at this hour.

March 21/3:00 PM (EST). (See Figures 5 and 6.)

An 190 foot segment of the Harborwalk directly north of future Phases B and C of the Biomedical Research Center will be in shadow at this hour. Portions of the entry plaza which will serve Phases B and C of the Biomedical Research Center also will be cast in shadow at this hour.

June 21: June 21 is the longest day of the year when shadows are shorter than at any other time.

June 21/9:00 AM (DST). (See Figures 7 and 8.)

Shadows from Building A will be cast on both sides of Sixteenth Street for those sections of Sixteenth Street that are adjacent to Building A and adjacent to the southern half of Building 114.

June 21/12 Noon (DST). (See Figures 9 and 10.)

The service driveway between Building A and Building 114 will be in shadow at this hour.

June 21/3:00 PM (DST). (See Figures 11 and 12.)

Portions of the entry plaza which will serve Phases B and C of the Biomedical Research Center will be cast in shadow at this hour.

September 21: Although September 21 is the Autumnal Equinox, Daylight Savings Time is in effect, and shadows are somewhat longer than they are at the same hour on the Vernal Equinox.

September 21/9:00 AM (DST). (See Figures 13 and 14.)

Shadows from Building A will be cast on portions of Sixteenth Street adjacent to Building A and adjacent to Building 114.

September 21/12 Noon (DST). (See Figures 15 and 16.)

The service driveway between Building A and Building 114 and a 50 foot segment of Harborwalk north of Building 114 will be cast in shadow at this hour.

September 21/3:00 PM (DST). (See Figures 17 and 18.)

An 120 foot segment of the Harborwalk directly north of future Phases B and C of the Biomedical Research Center will be in shadow at this hour. A small portion of the entry plaza which will serve Phases B and C of the Biomedical Research Center also will be shaded at this hour.

December 21: December 21 is the Winter Solstice when days are shortest, shadows longest, and outdoor activity is generally at a minimum.

December 21/9:00 AM (EST). (See Figures 19 and 20.)

Shadows from Building A will be cast on the service driveway between Building A and Building 114 and cast on a 40 foot segment of the Harborwalk located north of Building 114.

December 21/12 Noon (EST). (See Figures 21 and 22.)

A portion of the service driveway between Building A and Building 114 and a 235 foot segment of the Harborwalk will be cast in shadow at this hour.

December 21/3:00 PM (EST). (See Figures 23 and 24.)

A 220 foot segment of the Harborwalk directly north of future Phases B and C of the Biomedical Research Center will be in shadow at this hour, as will a small portion of the entry plaza which will serve Phases B and C of the Biomedical Research Center.

CONCLUSIONS

The mass and height of the Proposed Building A project will have minimal negative shadow impacts on proposed active pedestrian open space areas in the vicinity of the site. The shadow analysis indicates that the areas where net new shadow will be cast from Building A include the Harborwalk, Sixteenth Street, and the future Entry Plaza for Phases B and C of the Biomedical Research Center.

Entry Plaza - The northern portion of the future entry plaza area serving Biomedical Research Center Phases B and C will be in partial shadow at 3:00 PM for all four seasons studied (see Figures 6, 12, 18 and 24). However, the most extensive shadow cast on this area will be during the summer afternoons when the shading caused by Building A could be very desirable.

Sixteenth Street - Building A will cast shadows on Sixteenth Street at 9:00 AM in the morning during March, June and September (see Figures 2, 8 and 14). However, no shadows will be cast in this area in the winter.

Harborwalk - Building A will cast shadows on the Harborwalk during noon and 3:00 PM in September and cast shadows on the Harborwalk at 9:00 AM, Noon and 3:00 PM in March and December (see Figures 2, 4, 6, 16, 18, 20, 22 and 24).

MITIGATION

The net new shadows generated by Building A fall within the general guidelines for shadow impact stipulated by the June 1991 Charlestown Navy Yard Redevelopment Draft Supplemental Environmental Impact Report (DSEIR). The DSEIR indicates that the overall development of the Charlestown Navy Yard Master Plan is designed to enhance sunlight in areas of greatest pedestrian activity. In this respect, net new shadows cast by Building A have a minimal adverse impact on high activity pedestrian areas in the vicinity of the site. Building A will have no adverse shadow impact on Yard's End Park, or the First Avenue and Second Avenue pedestrian thoroughfares. However, Building A will have some shadow impact on the Harborwalk adjacent to parcel 7 during fall, winter, and spring, but not during the summer.

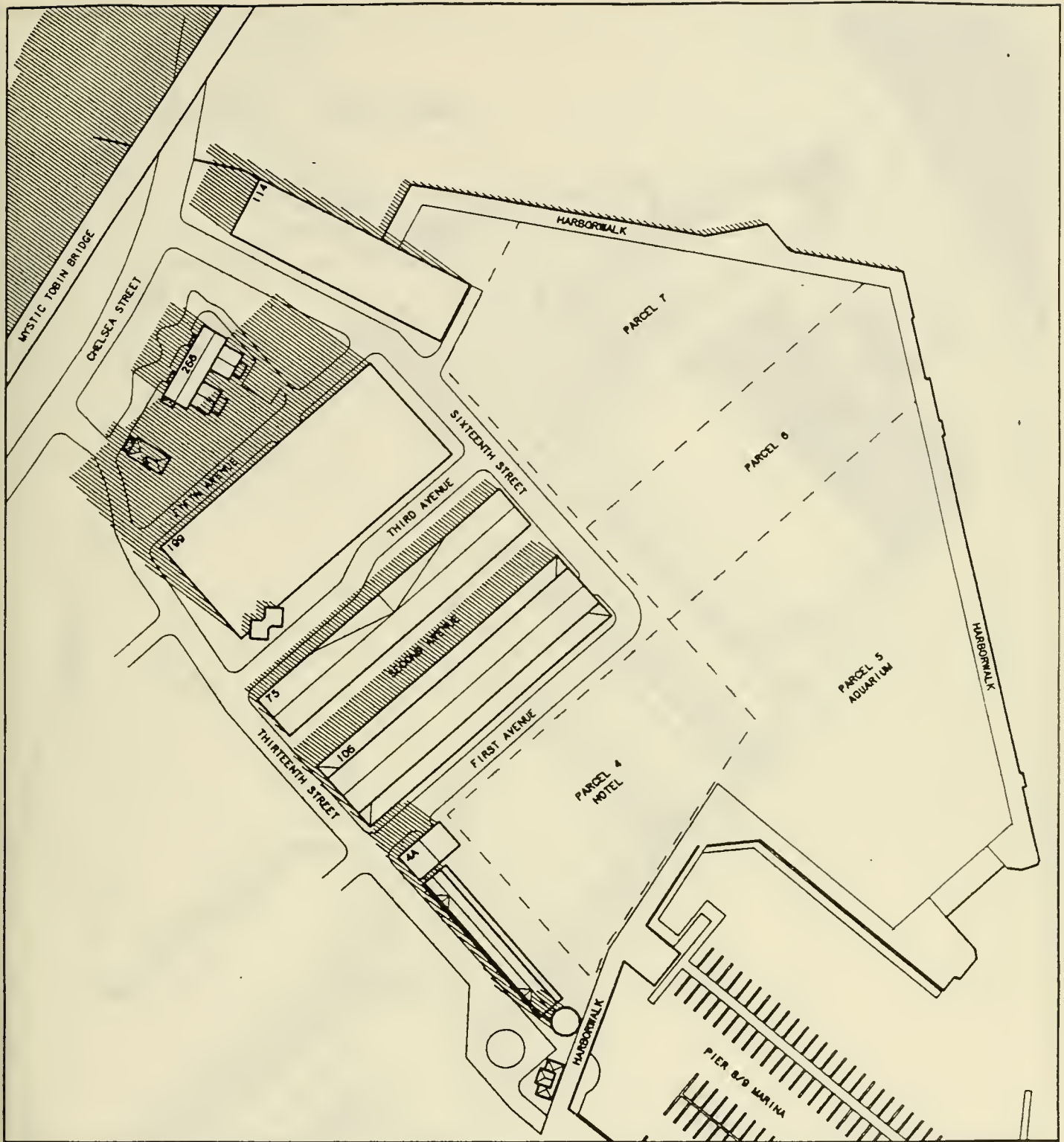


FIGURE: 1

EXISTING CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

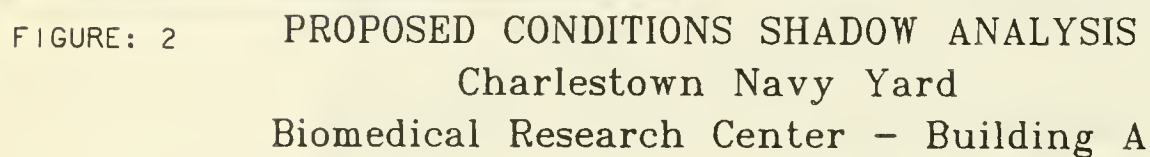
MARCH 21, 9:00 AM
 BEARING: 127
 ALTITUDE: 33



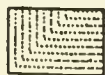
EXISTING CONDITION
 SHADOWS

200 0 200
 100
 1 IN FEET

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 1 AUGUST 1991



EXISTING CONDITION
SHADOWS



NET NEW SHAOWS
(BIOMEDICAL RESEARCH
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1 AUGUST 1991

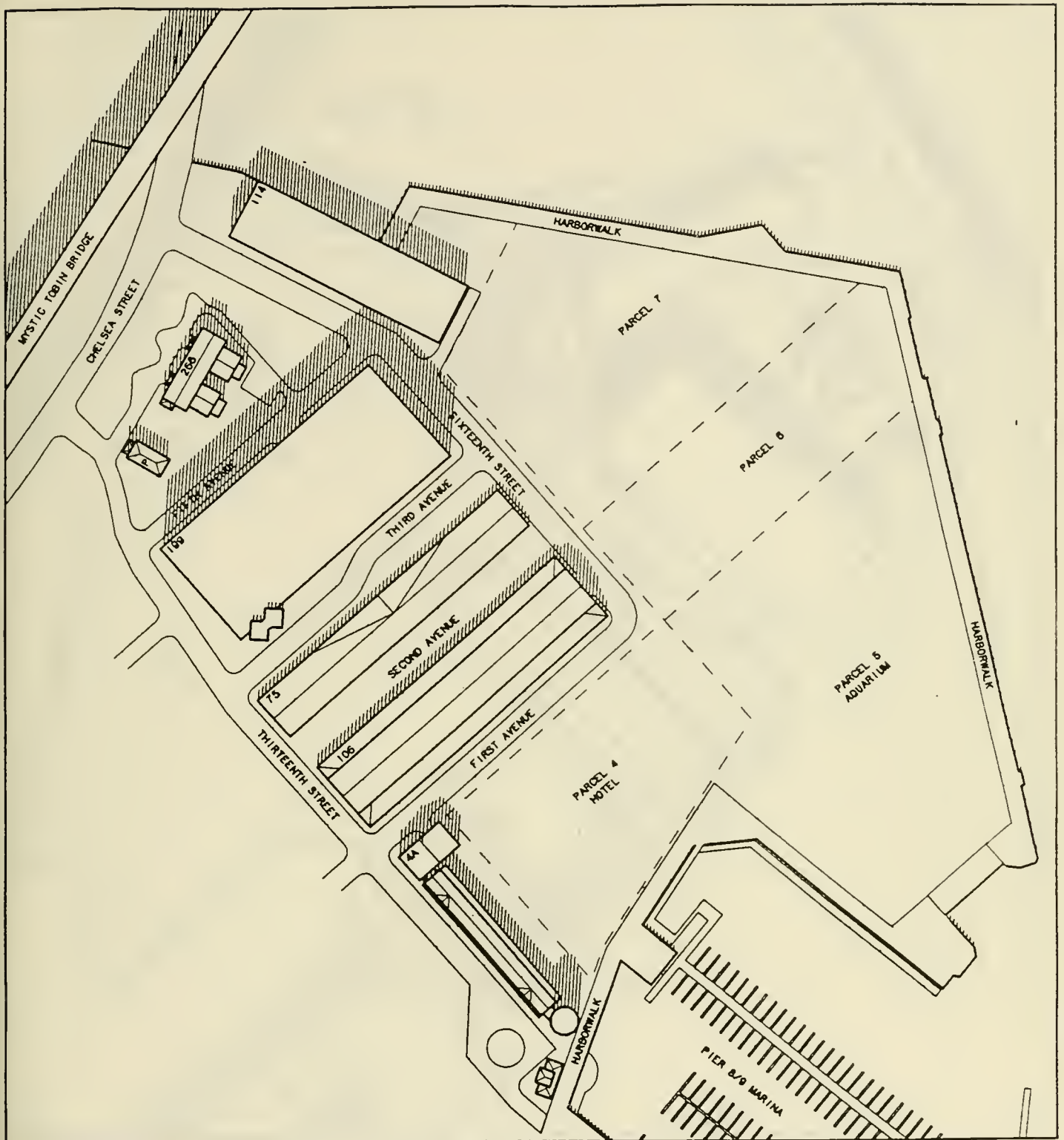


FIGURE: 3

EXISTING CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

MARCH 21, 12:00 PM
 BEARING: 184
 ALTITUDE: 48



EXISTING CONDITION
 SHADOWS

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200 0 200
 100
 IN FEET

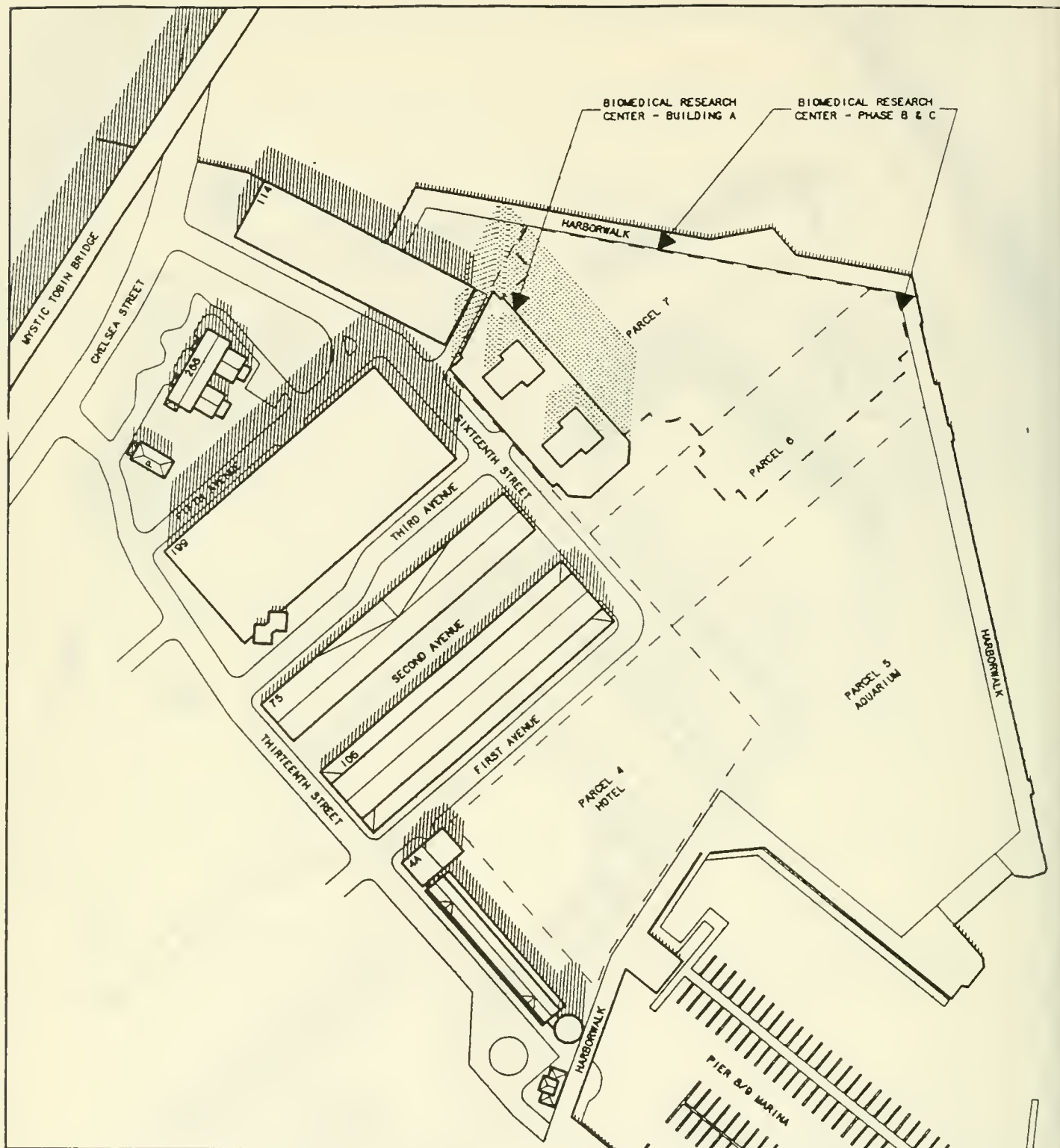


FIGURE: 4 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center - Building A

MARCH 21, 12:00 PM
 BEARING: 184
 ALTITUDE: 48



200 0 200
 IN FEET



EXISTING CONDITION
 SHADOWS



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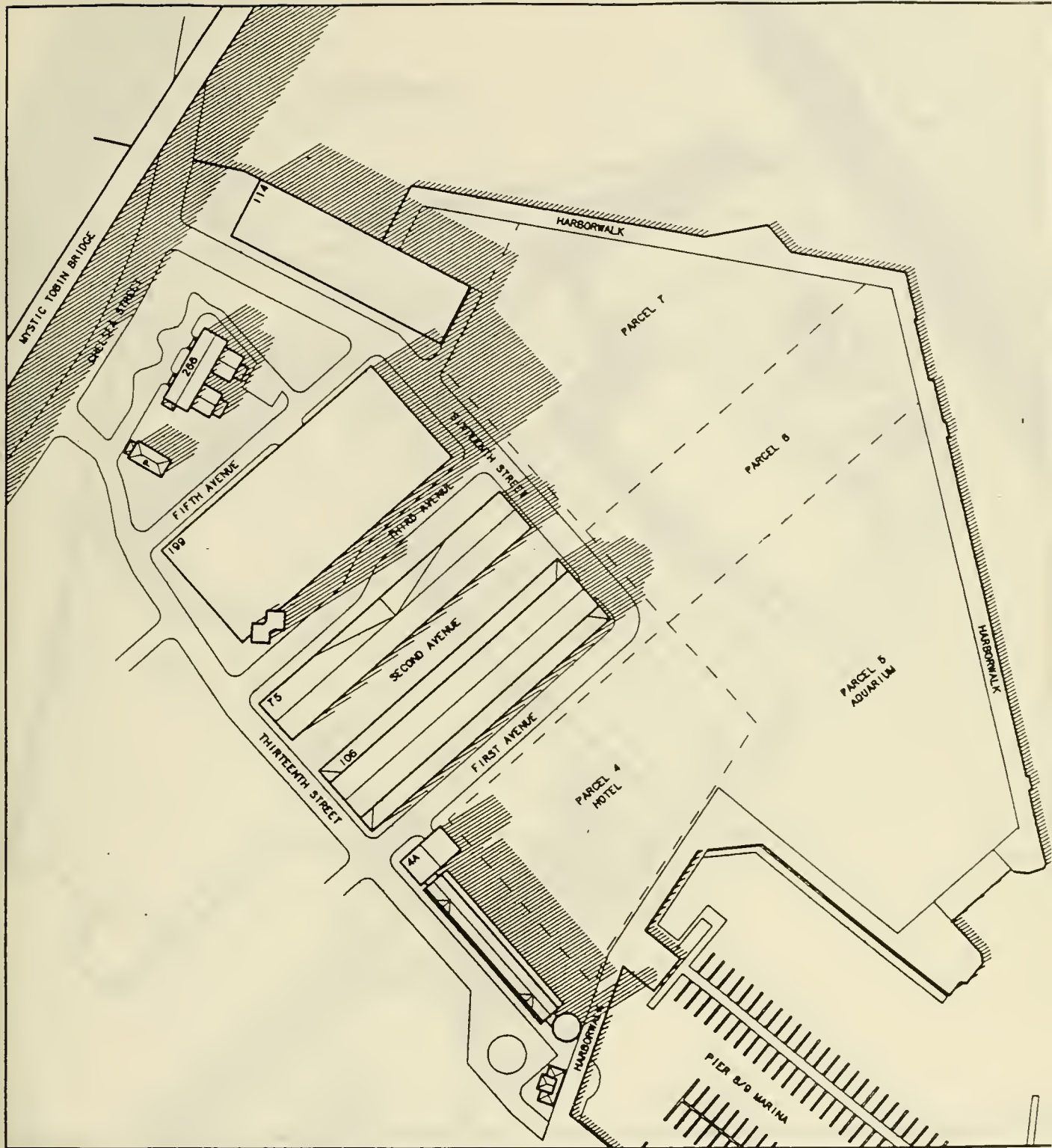


FIGURE: 5

EXISTING CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

MARCH 21, 3:00 PM
 BEARING: 238
 ALTITUDE: 30



EXISTING CONDITION
 SHADOWS

200 0
 100
 IN FEET 200

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 1 AUGUST 1991

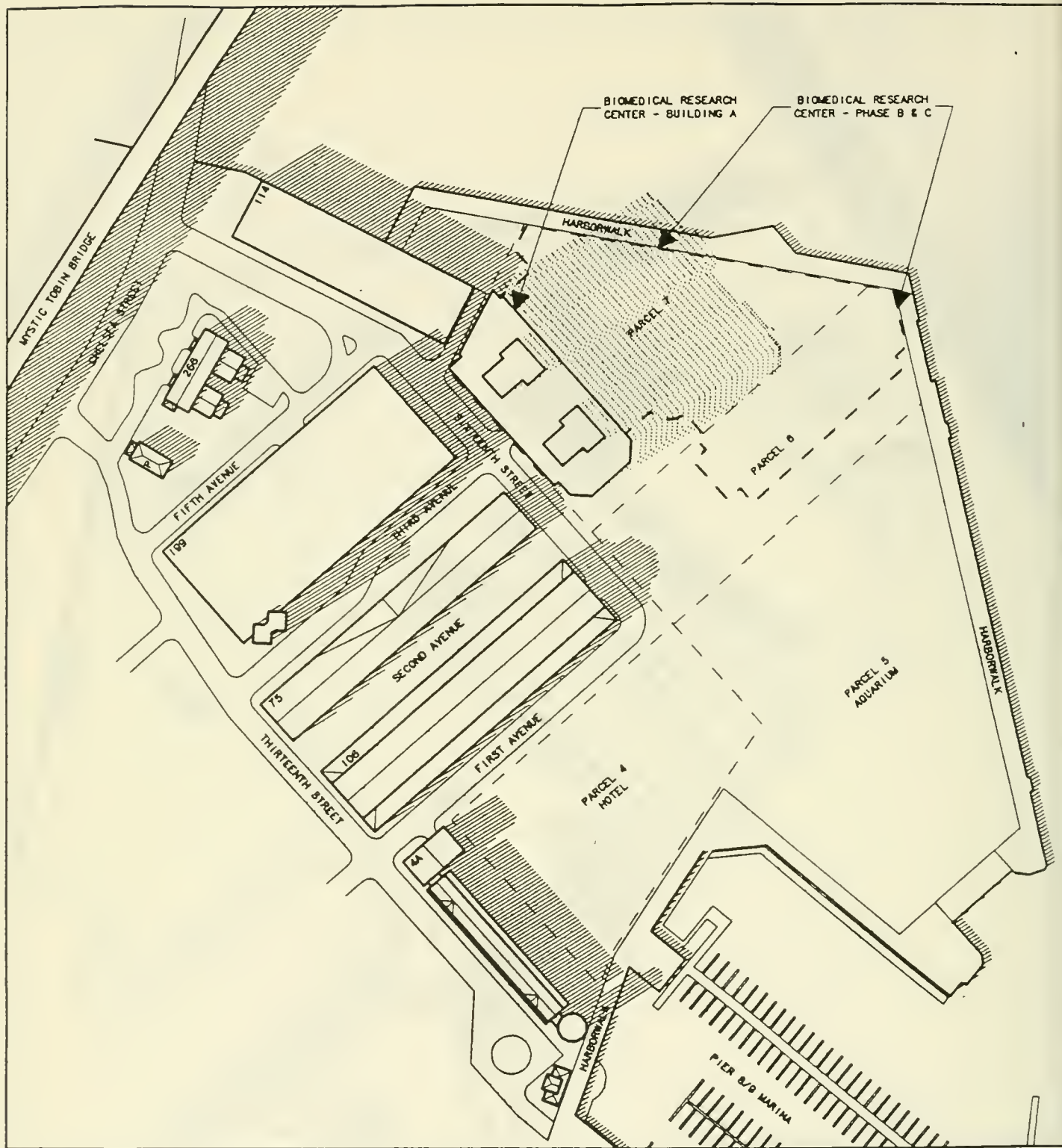
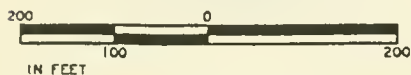


FIGURE: 6

PROPOSED CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

MARCH 21, 3:00 PM
 BEARING: 238
 ALTITUDE: 30



EXISTING CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL RESEARCH
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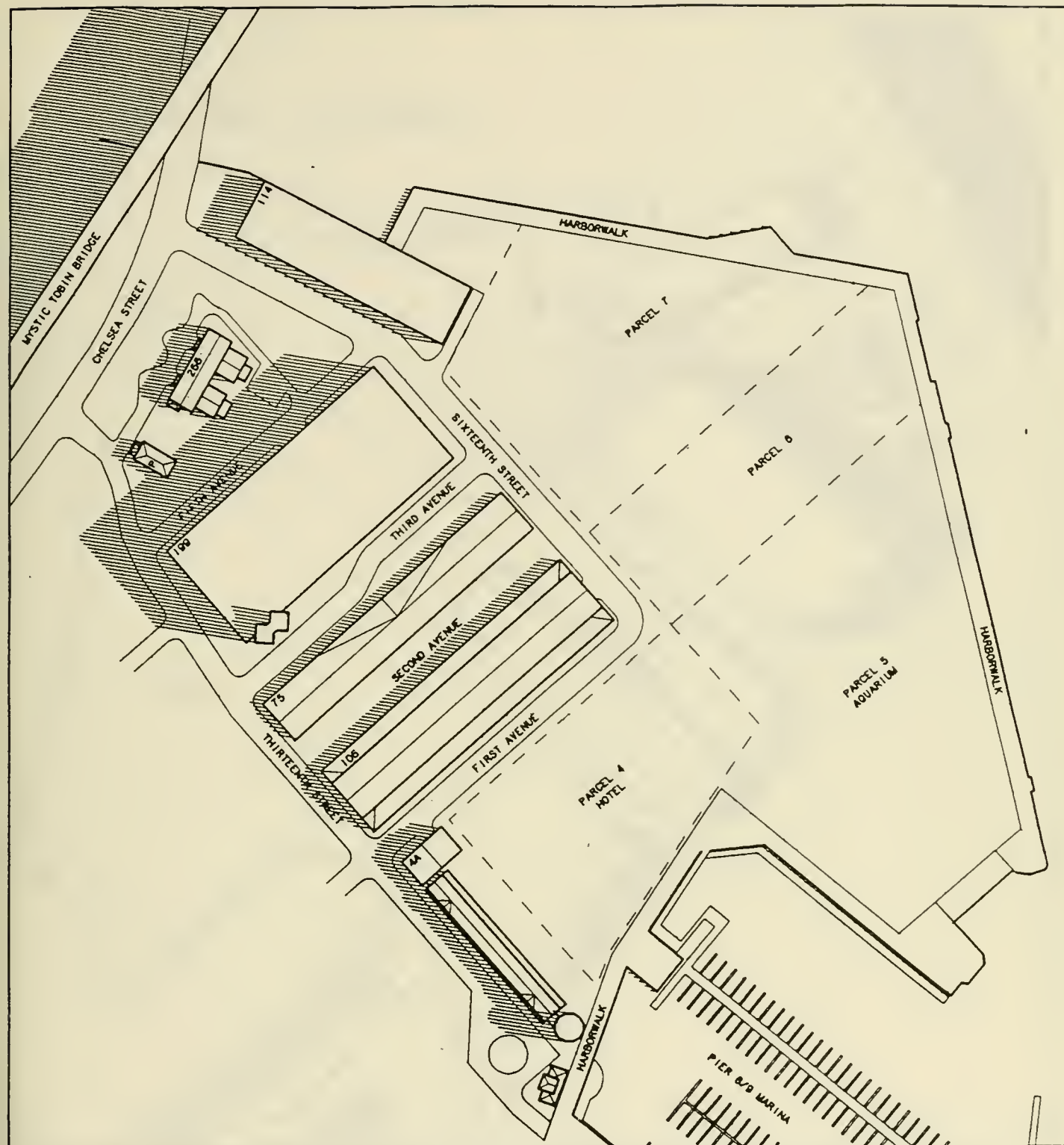


FIGURE: 7 EXISTING CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center - Building A

JUNE 21, 9:00 AM
 BEARING: 99
 ALTITUDE: 40



EXISTING CONDITION
 SHADOWS

PREPARED BY:
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 WATERTOWN, MA. 02172
 1 AUGUST 1991

200 0 200
 100
 IN FEET

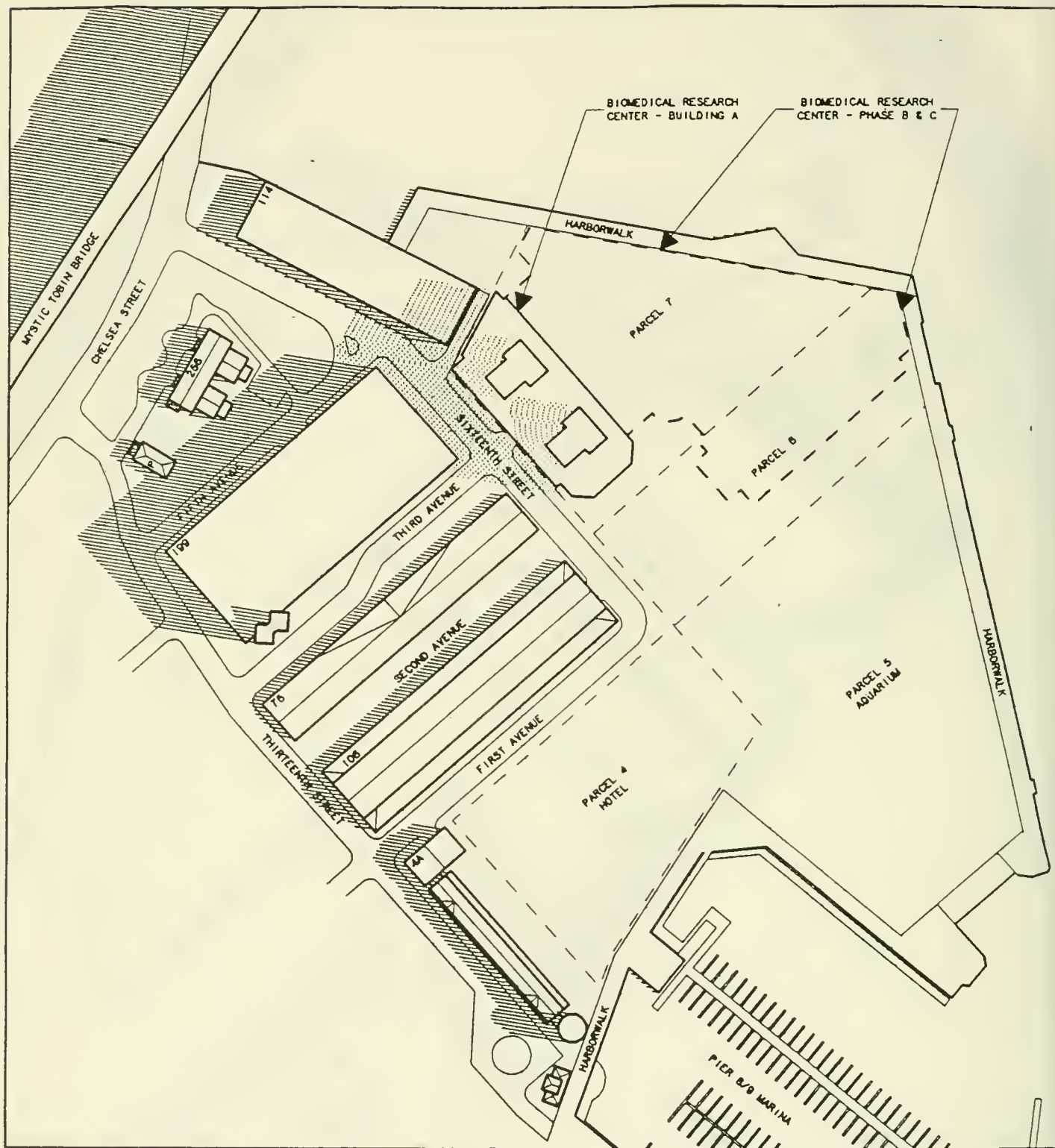


FIGURE: 8 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center - Building A

JUNE 21, 9:00 AM
 BEARING: 99
 ALTITUDE: 40



200 0 200
 IN FEET



EXISTING CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL RESEARCH
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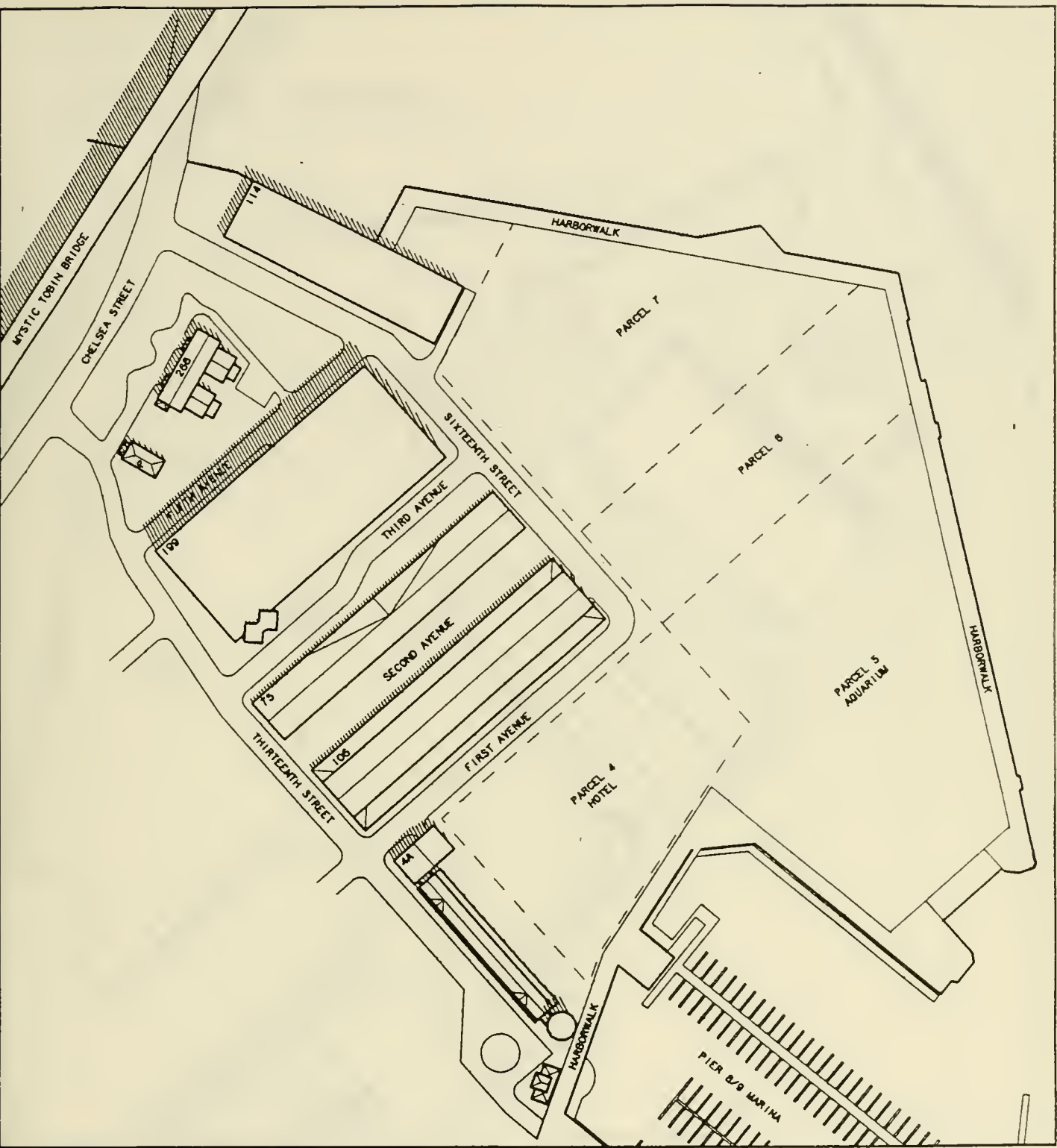
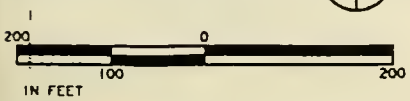


FIGURE: 9

EXISTING CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

JUNE 21, 12:00 PM
 BEARING: 152
 ALTITUDE: 69



 EXISTING CONDITION
 SHADOWS

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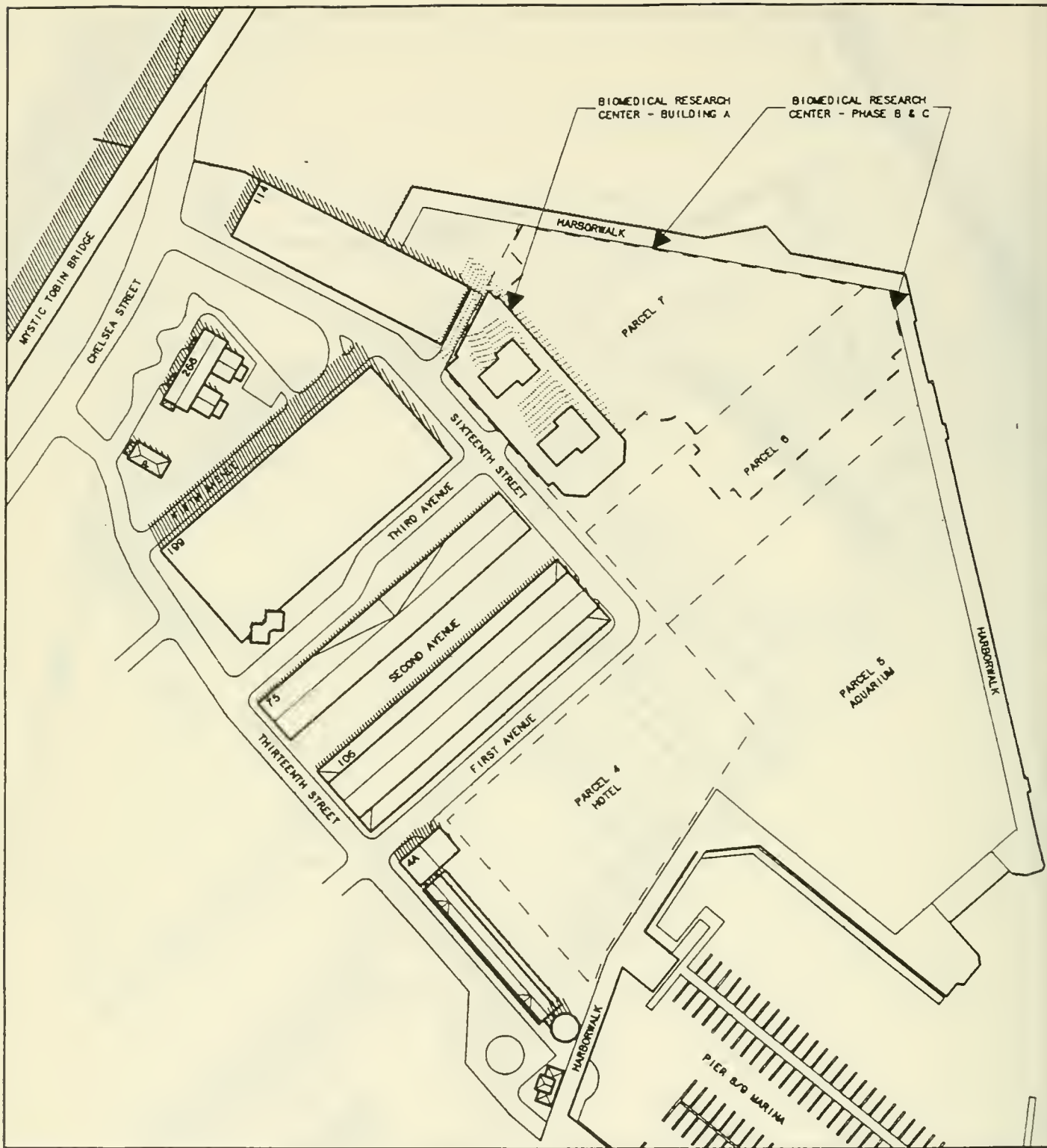
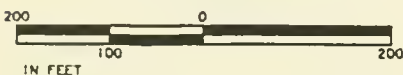


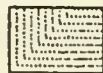
FIGURE: 10

PROPOSED CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

JUNE 21, 12:00 PM
 BEARING: 152
 ALTITUDE: 69



EXISTING CONDITION
 SHADOWS



NET NEW SHADOWS
 BIOMEDICAL RESEARCH
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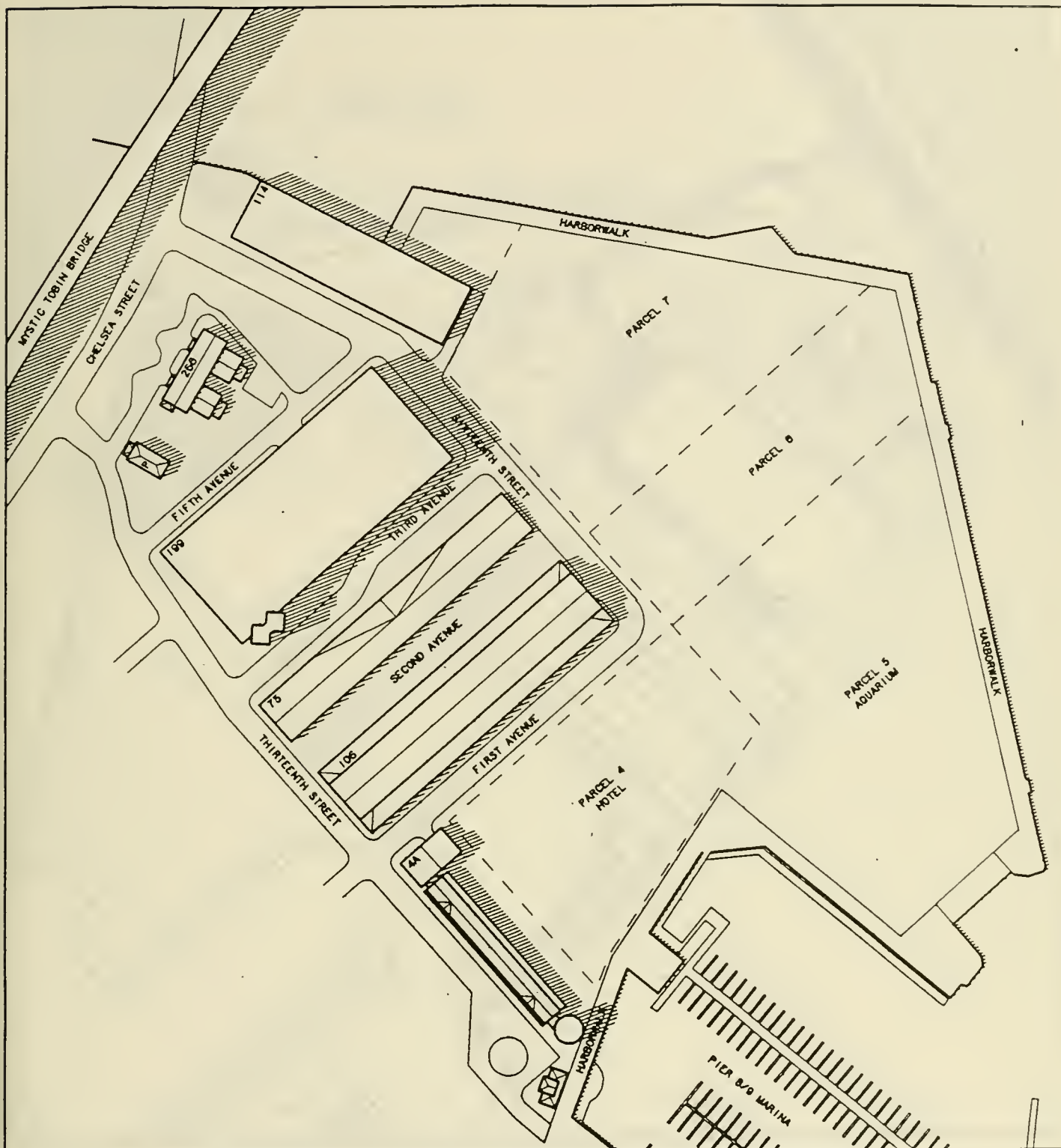


FIGURE: 11

EXISTING CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

JUNE 21, 3:00 PM
 BEARING: 248
 ALTITUDE: 56



EXISTING CONDITION
 SHADOWS

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200 0 100 200
 IN FEET

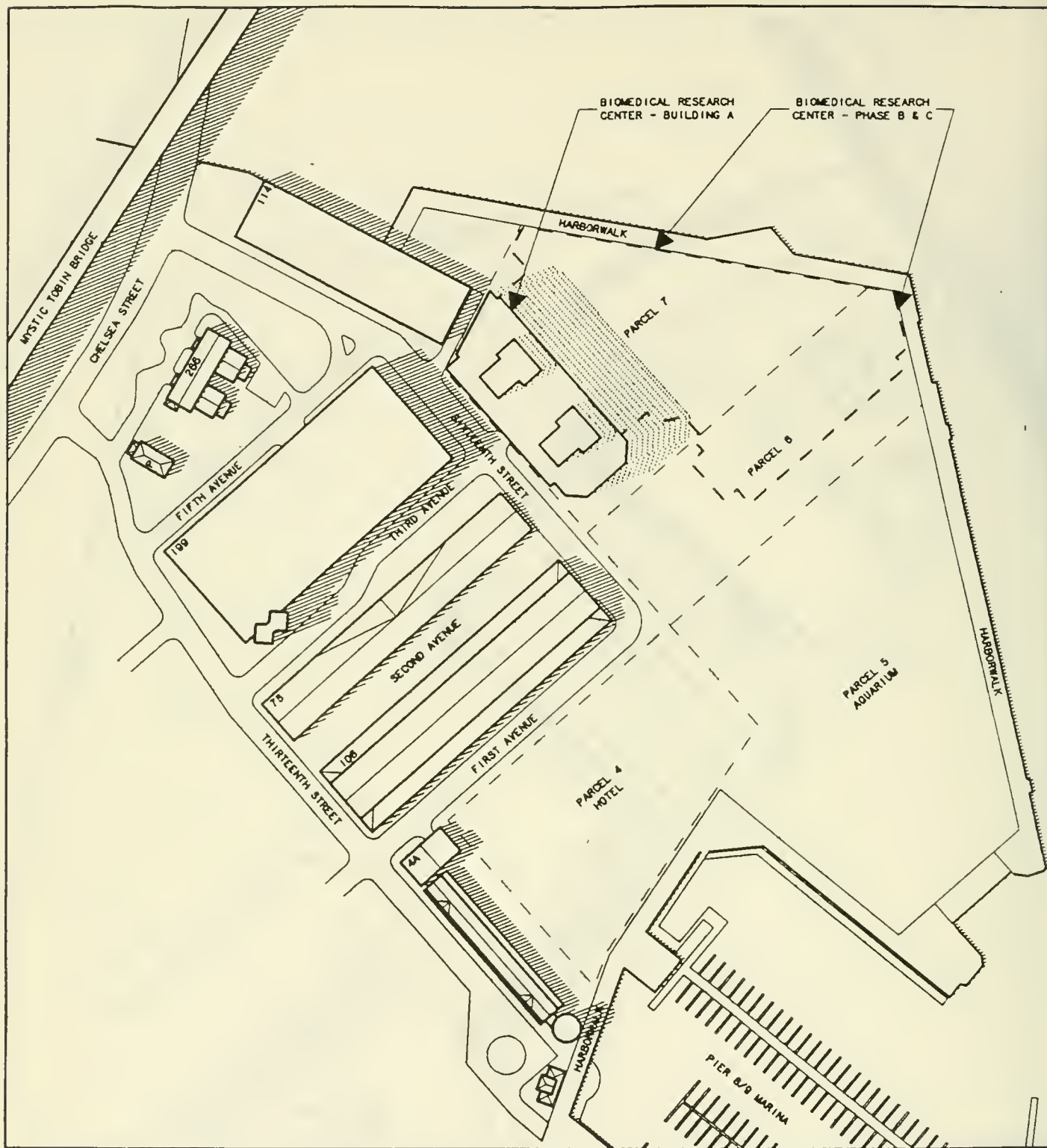


FIGURE: 12

PROPOSED CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

JUNE 21, 3:00 PM
 BEARING: 248
 ALTITUDE: 56



200 0 200
 IN FEET



EXISTING CONDITION
 SHADOWS



NET NEW SHADOWS
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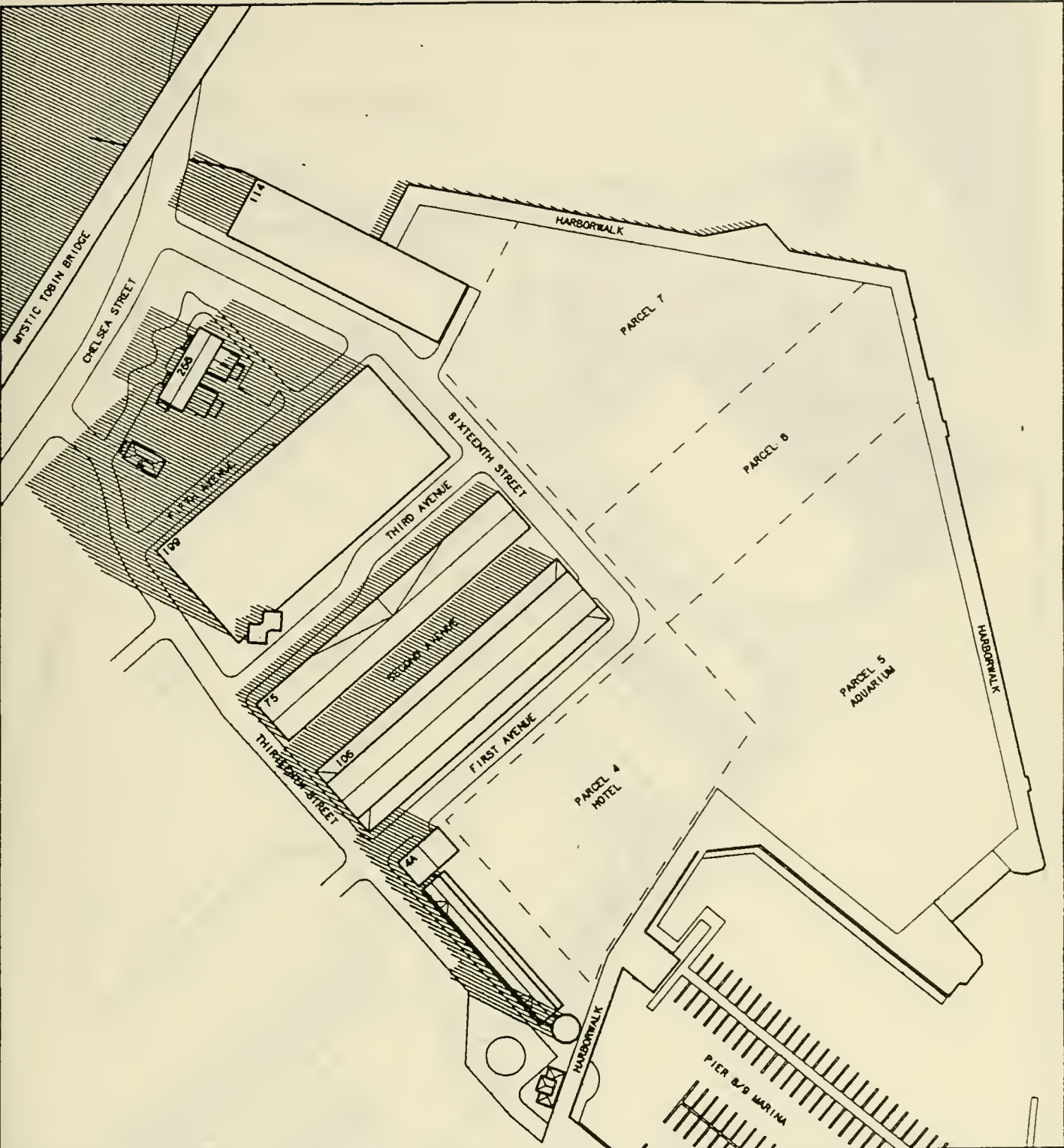
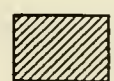


FIGURE: 13

EXISTING CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

SEPTEMBER 21, 9:00 AM
 BEARING: 117
 ALTITUDE: 27



 EXISTING CONDITION SHADOWS

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 WATERTOWN, MA. 02172
 1 AUGUST 1991



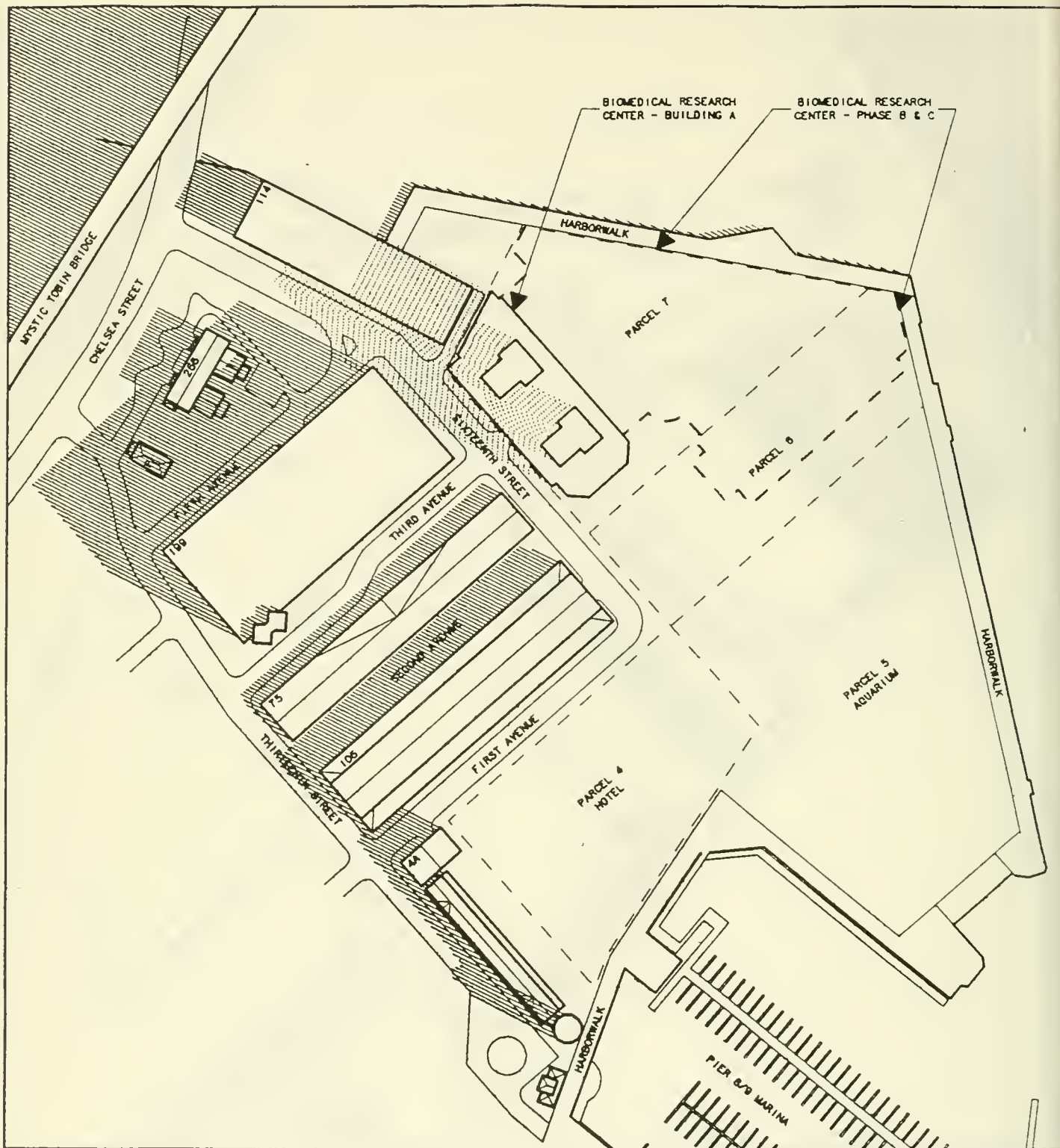
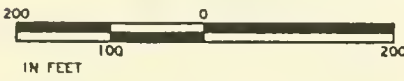


FIGURE: 14 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center - Building A

SEPTEMBER 21, 9:00 AM
 BEARING: 117
 ALTITUDE: 27



EXISTING CONDITION SHADOWS
 NET NEW SHADOWS (BIOMEDICAL RESEARCH CENTER - BUILDING 1)

PREPARED BY:
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 WATERTOWN, MA. 02172
 1 AUGUST 1991

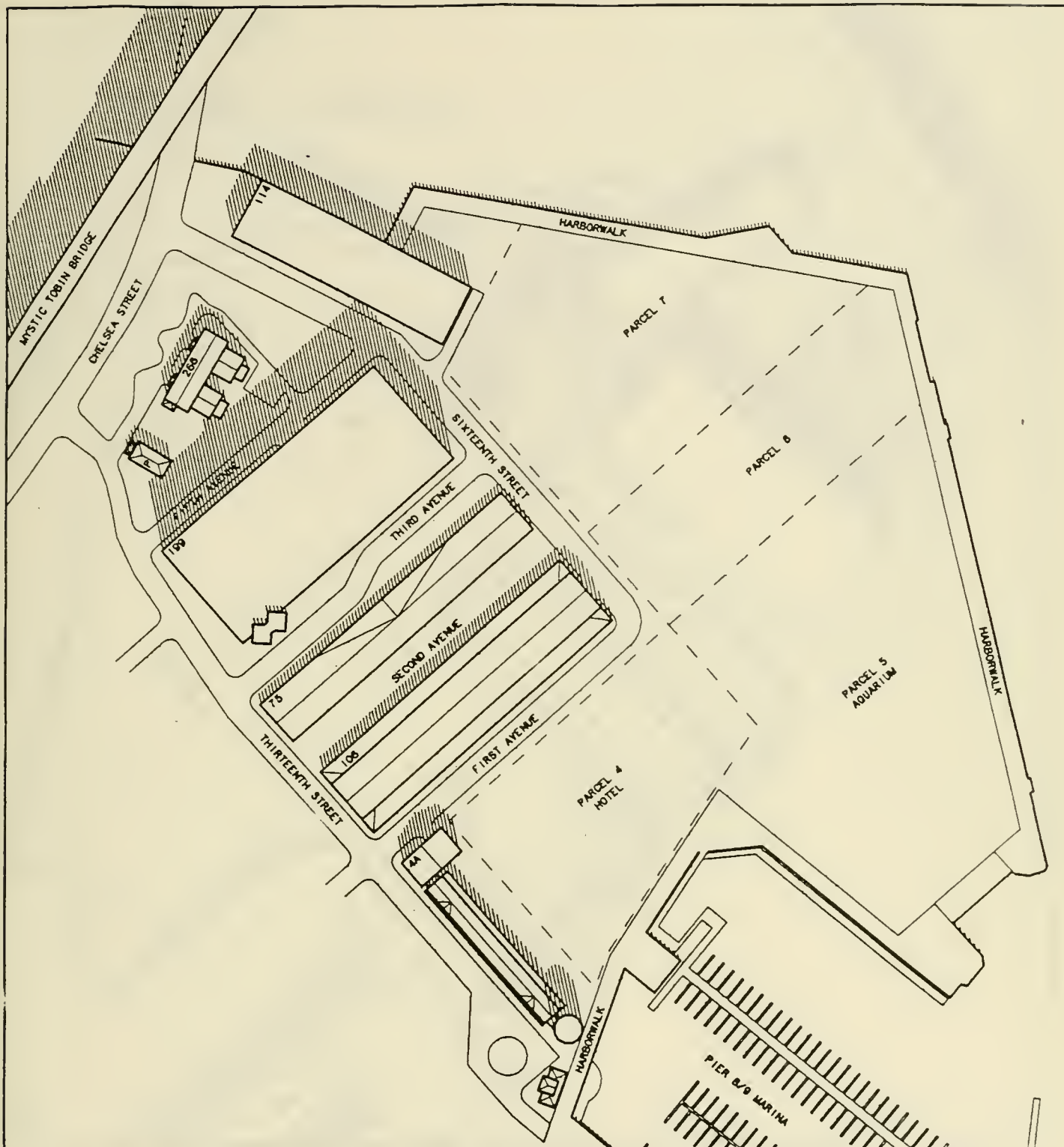


FIGURE: 15

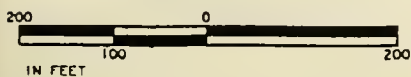
EXISTING CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

SEPTEMBER 21, 12:00 PM
 BEARING: 168
 ALTITUDE: 47



EXISTING CONDITION
 SHADOWS

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 1 AUGUST 1991



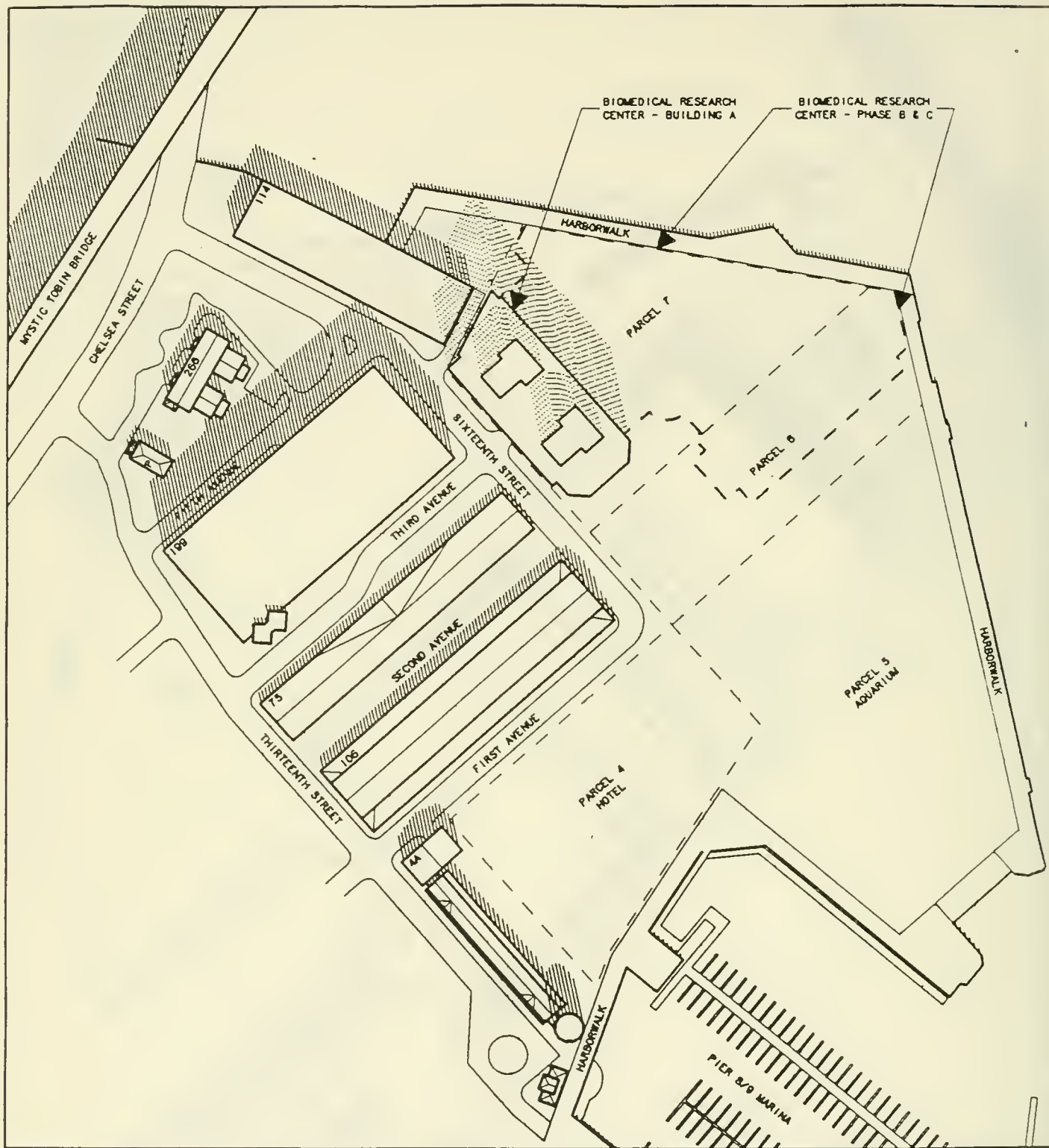


FIGURE: 16

PROPOSED CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

SEPTEMBER 21, 12:00 PM
 BEARING: 168
 ALTITUDE: 47



200 0 200
 IN FEET



EXISTING CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL RESEARCH
 CENTER - BUILDING 1)

PREPARED BY:
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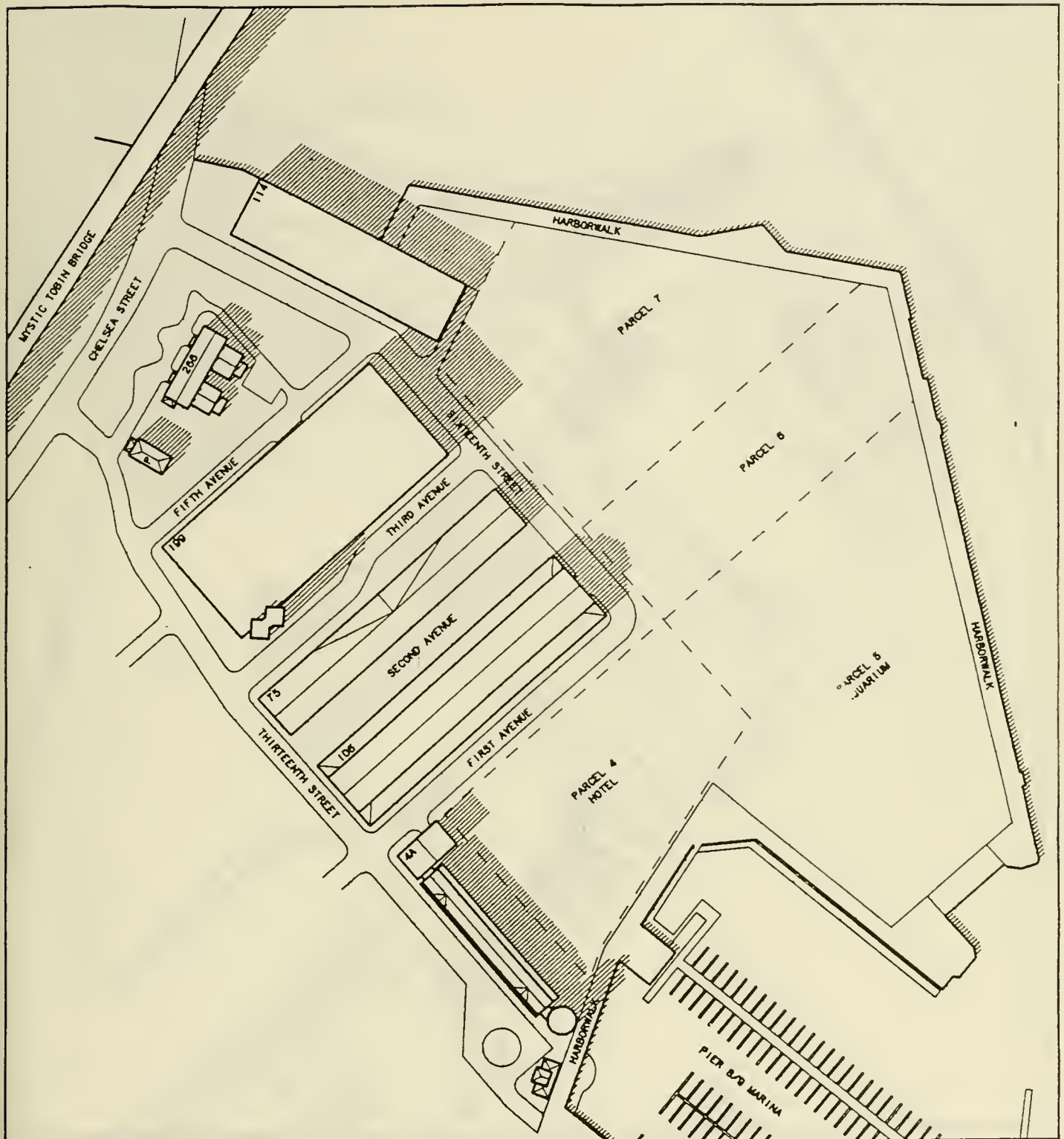


FIGURE: 17

EXISTING CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

SEPTEMBER 21, 3:00 PM
 BEARING: 227
 ALTITUDE: 37



EXISTING CONDITION
 SHADOWS

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 1 AUGUST 1991

200 0 200
 100
 IN FEET

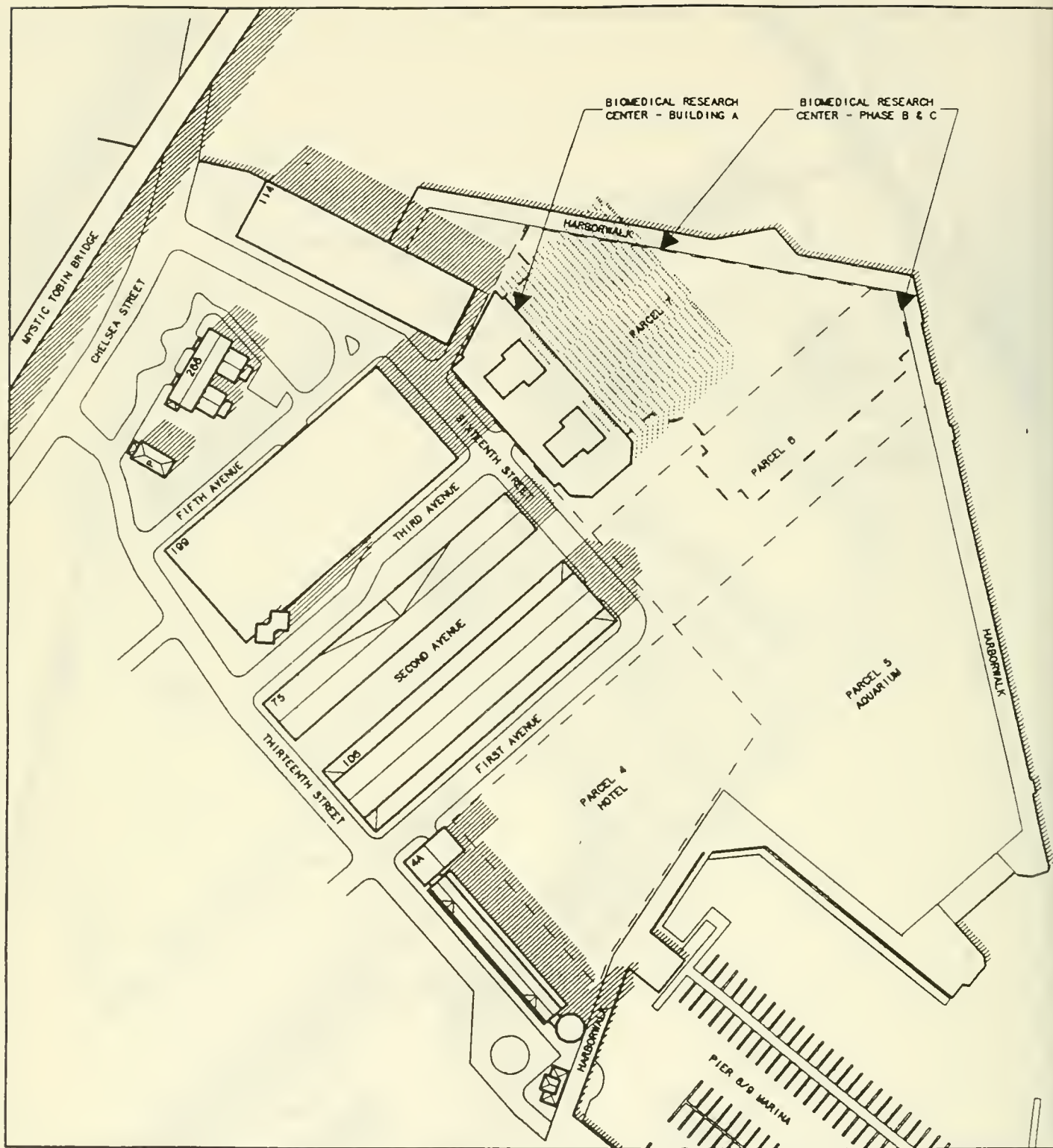


FIGURE: 18

PROPOSED CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

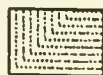
SEPTEMBER 21, 3:00 PM
 BEARING: 227
 ALTITUDE: 37



200 0 200
 IN FEET



EXISTING CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL RESEARCH
 CENTER - BUILDING 1)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 1 AUGUST 1991

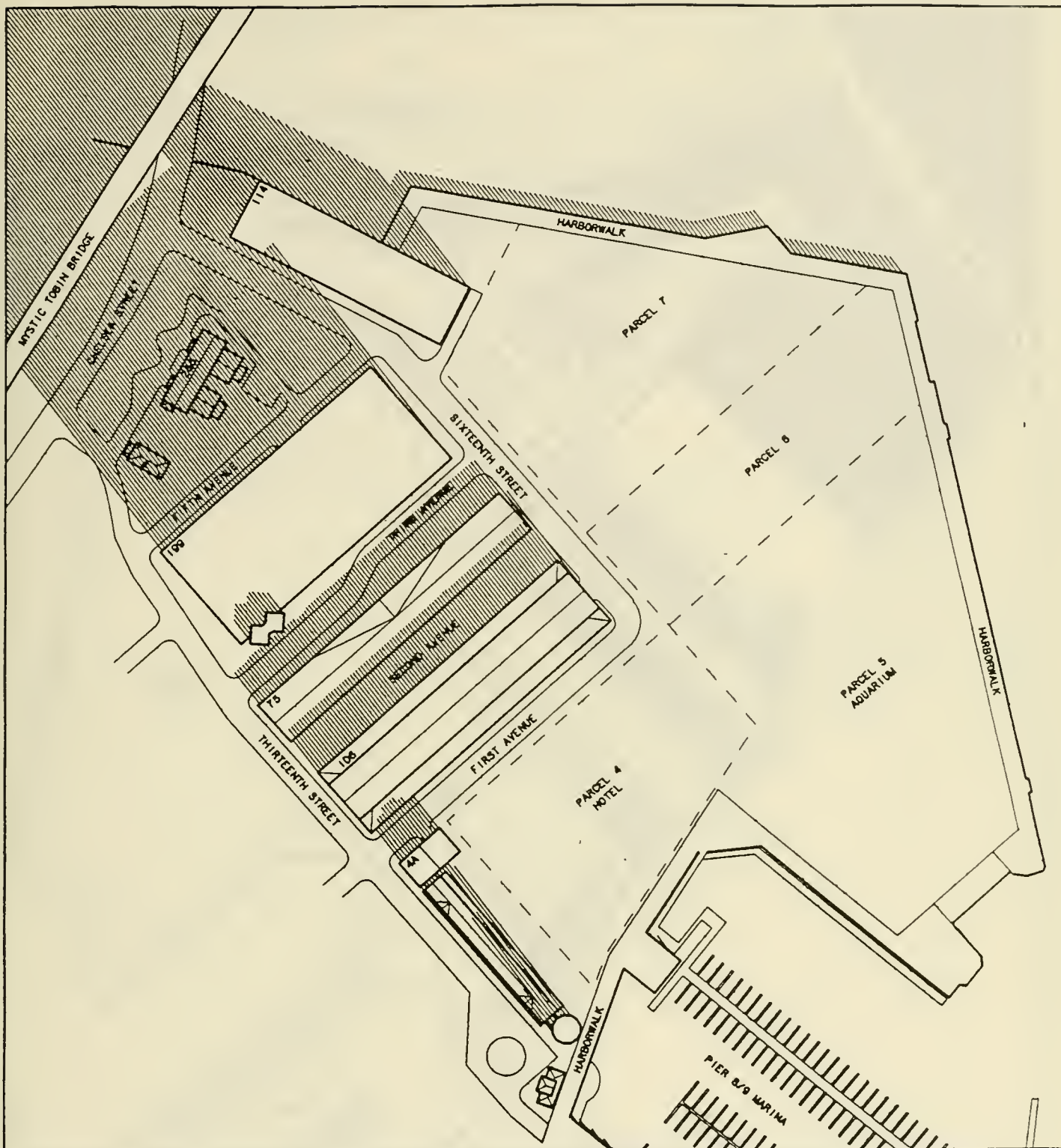


FIGURE: 19

EXISTING CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

DECEMBER 21, 9:00 AM
 BEARING: 142
 ALTITUDE: 15



EXISTING CONDITION
 SHADOWS

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 1 AUGUST 1991

200 0 100 200
 IN FEET

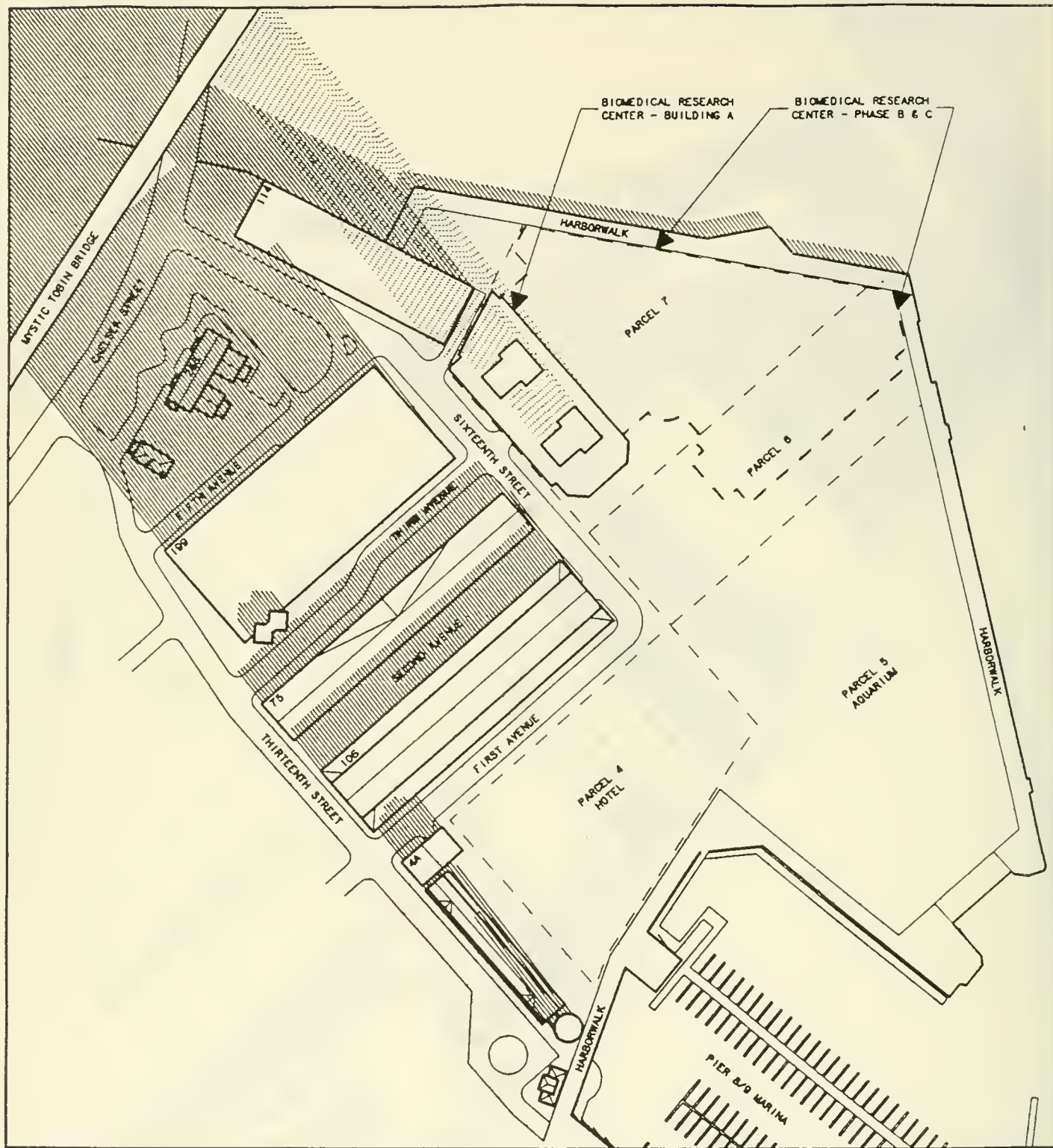


FIGURE: 20

PROPOSED CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

DECEMBER 21, 9:00 AM
 BEARING: 142
 ALTITUDE: 15



200 0 200
 IN FEET



EXISTING CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL RESEARCH
 CENTER - BUILDING 1)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 1 AUGUST 1991

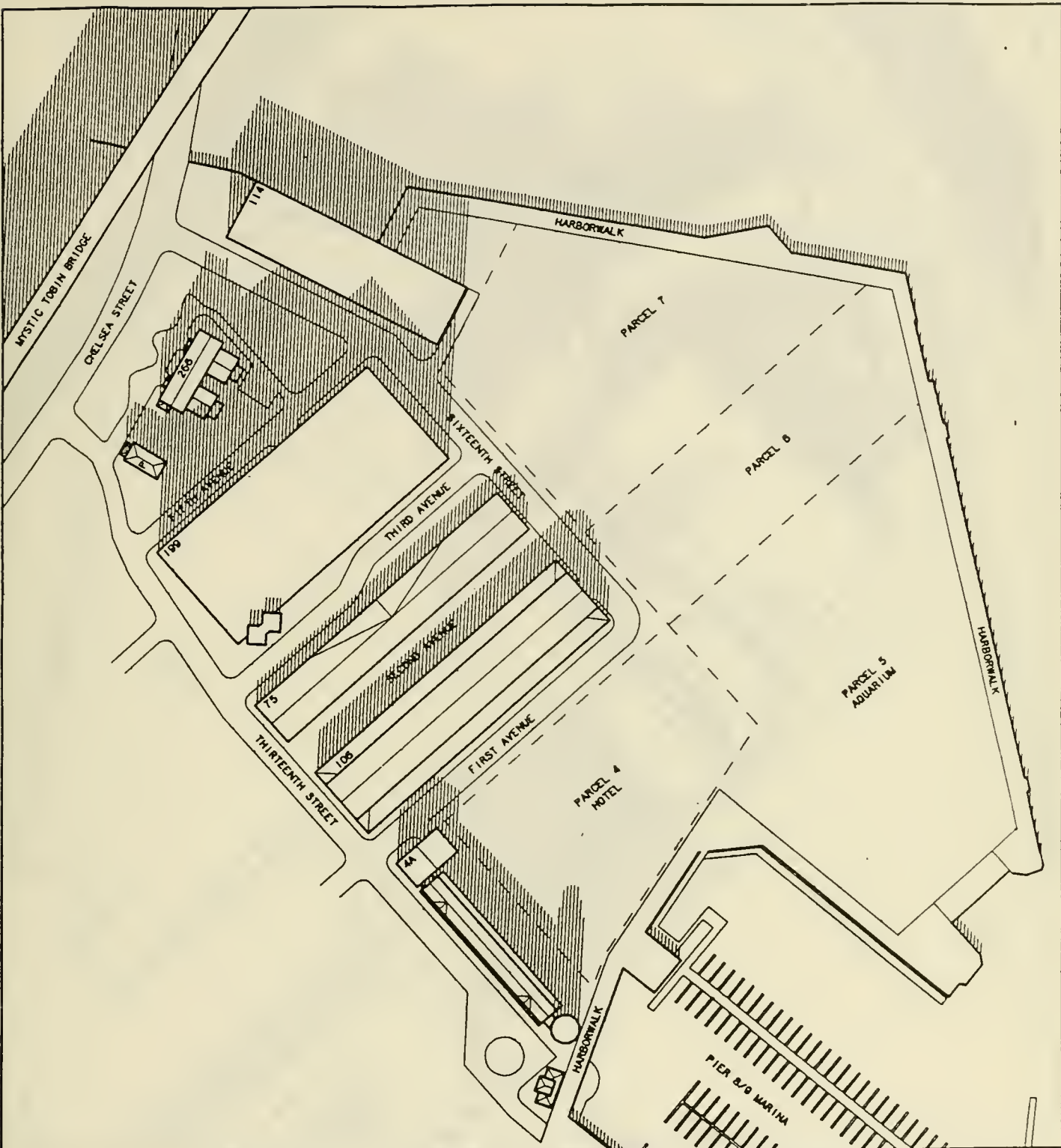


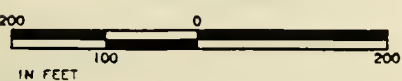
FIGURE: 21 EXISTING CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center - Building A

DECEMBER 21, 12:00 PM
 BEARING: 183
 ALTITUDE: 25



 EXISTING CONDITION SHADOWS

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 1 AUGUST 1991



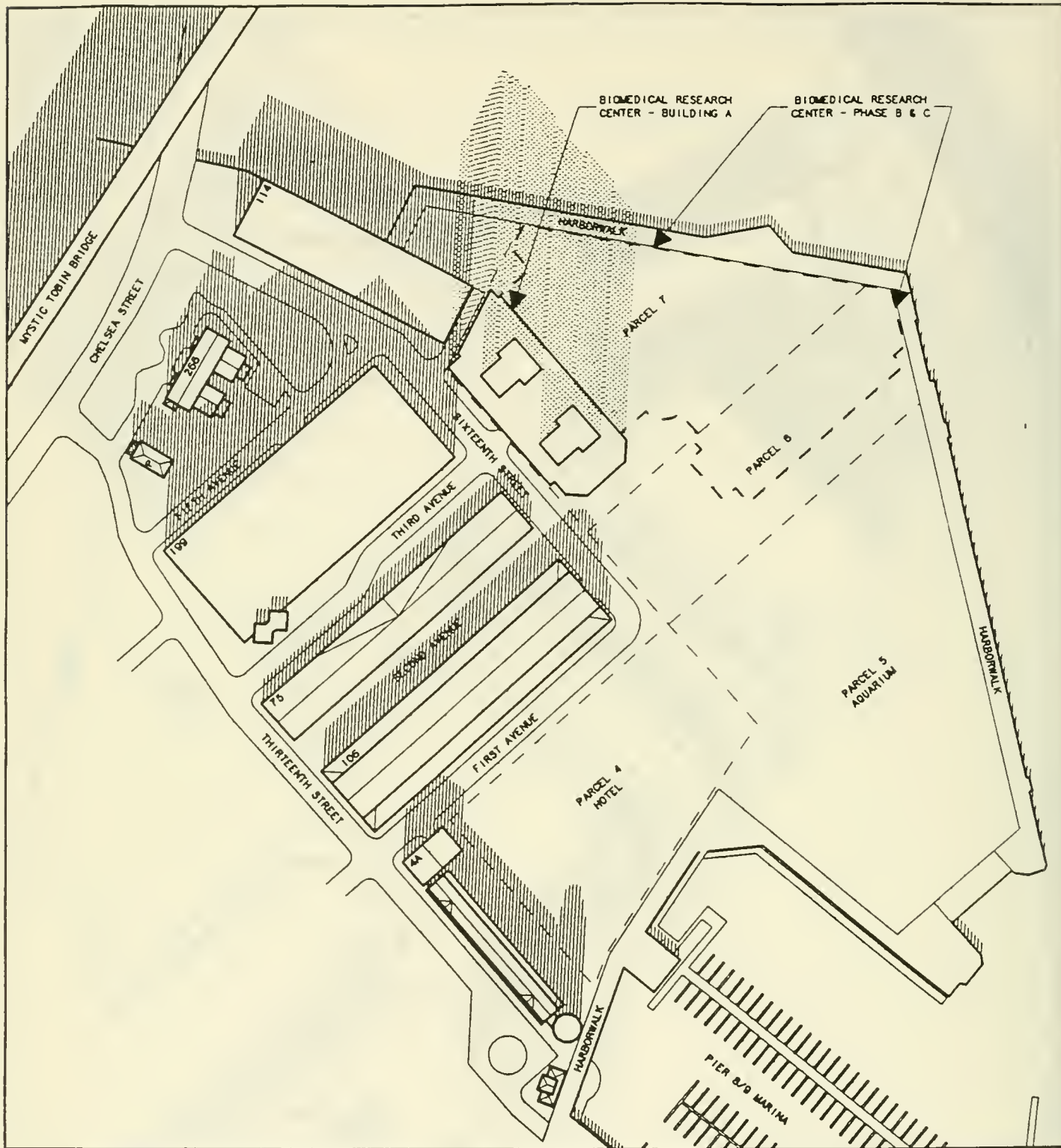


FIGURE: 22 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center - Building A

DECEMBER 21, 12:00 PM
 BEARING: 183
 ALTITUDE: 25



200 0 200
 IN FEET



EXISTING CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL RESEARCH
 CENTER - BUILDING 1)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 1 AUGUST 1991

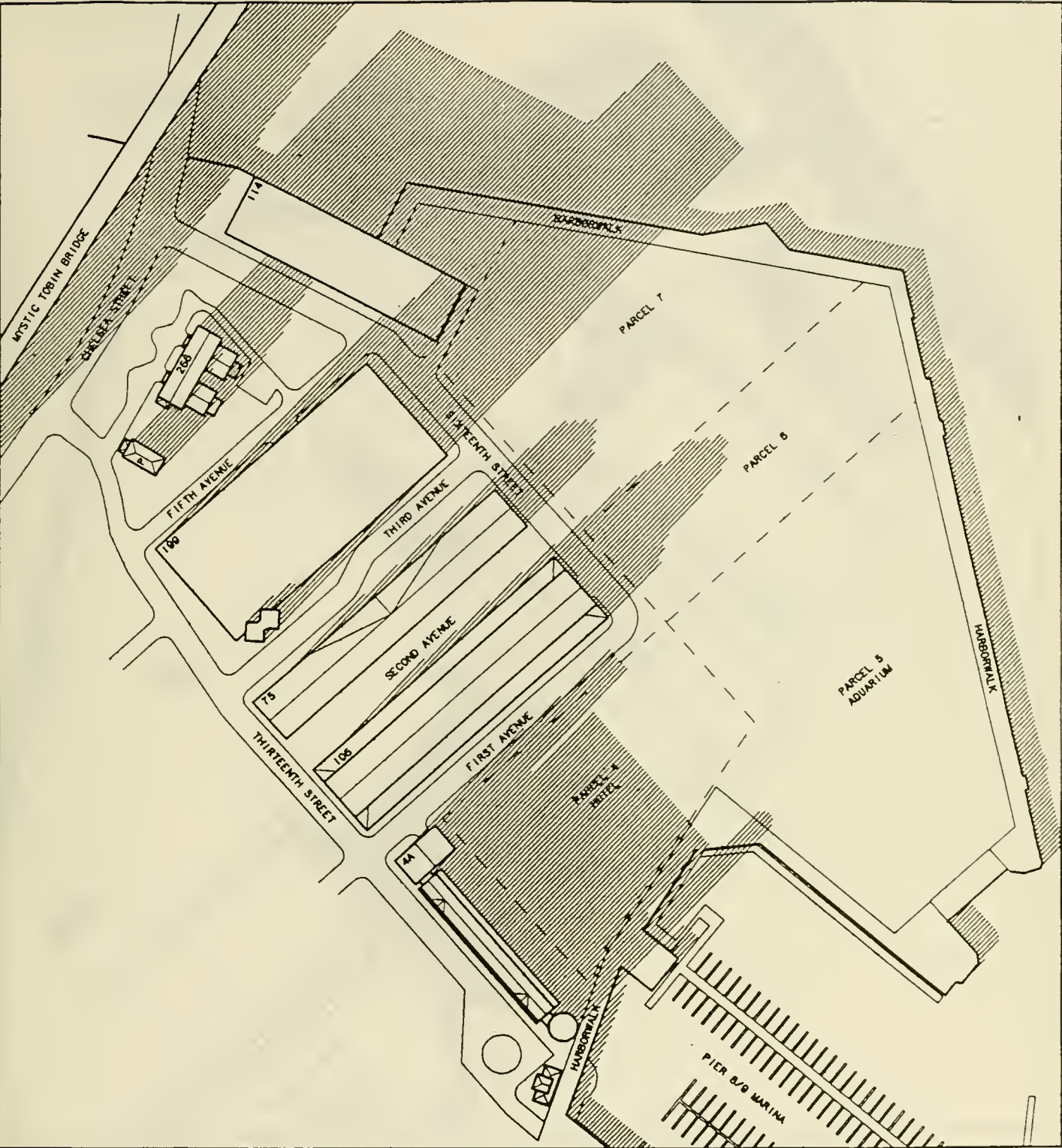


FIGURE: 23 EXISTING CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center - Building A

DECEMBER 21, 3:00 PM
 BEARING: 224
 ALTITUDE: 11

200 0 200
 IN FEET

 EXISTING CONDITION SHADOWS

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 1 AUGUST 1991

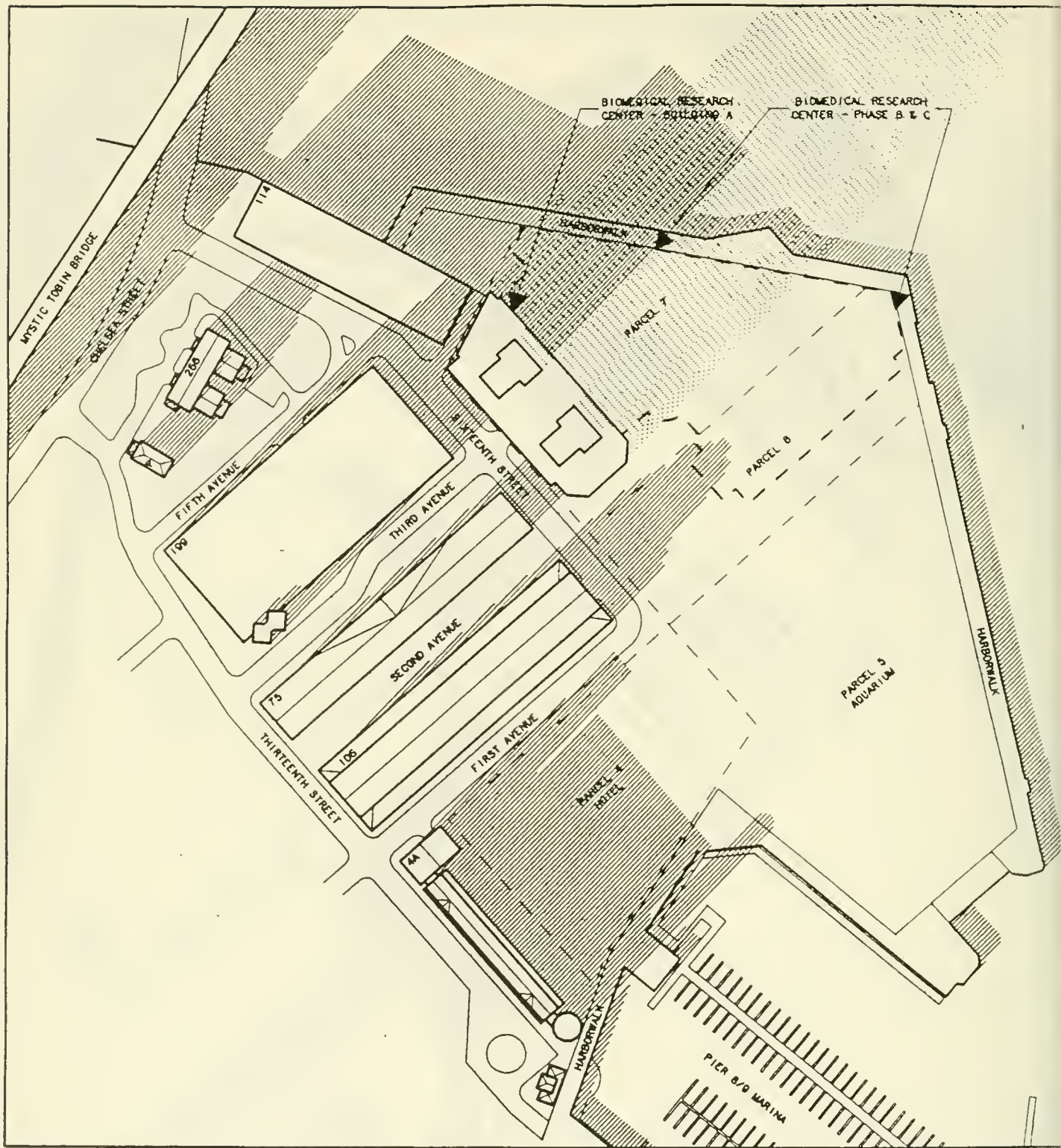


FIGURE: 24

PROPOSED CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Building A

DECEMBER 21, 3:00 PM
 BEARING: 224
 ALTITUDE: 11



200 0 200
 IN FEET



EXISTING CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL RESEARCH
 CENTER - BUILDING 1)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 1 AUGUST 1991

APPENDIX G2
PARCEL 4 HOTEL

90-91-2303

CHARLESTOWN NAVY YARD

**Shadow Analysis of
the Parcel 4 Hotel**

Prepared for: Boston Redevelopment Authority

Prepared by: Sasaki Associates, Inc.

Date: August 19, 1991

INTRODUCTION

This study addresses the shadow impacts of the hotel proposed for Parcel 4 at the Charlestown Navy Yard. The focus of the study is on the shadows that fall on pedestrian and open space areas near the building. Open space areas of concern include First Avenue, Yard's End Park (which includes the entry plazas to the proposed Biomedical Research Center and the New England Aquarium), and the Harborwalk.

EXISTING AND PROPOSED CONDITIONS

The base condition analyzed herein as "existing conditions" includes Buildings 114, 199, 75, 106, and 4A as well as the addition to Building 114 and Building A of the Biomedical Research Center. According to phasing plans for the buildout of the Yard's End area of the Navy Yard, all of these buildings will be completed or occupied when the hotel is built. Therefore, they are all included in the base condition analysis.

The proposed project is part of the Charlestown Navy Yard Redevelopment Plan. Uses studied in the Proposed Condition include the following:

Proposed Uses

- A 400 suite hotel located on Parcel 4 just north of the Pier 8/9 Marina.

Pedestrian Areas

- *Harborwalk* - a continuous pedestrian walkway along the water's edge providing a pedestrian link between the U.S.S. Constitution and the Aquarium and other Navy Yard uses, and extending to the perimeter of the Little Mystic Channel.
- *Yard's End Park* - a park space and plaza located at the end of First and Second Avenues between the Aquarium site and Building A of the Biomedical Research Center.
- *First Avenue* - an auto and pedestrian route.
- *Second Avenue* - a pedestrian promenade.
- *Sixteenth Street* - a secondary auto and pedestrian route.

METHODOLOGY

Shadows were projected for the Parcel 4 hotel on four (4) key days of the year: March 21, June 21, September 21, and December 21 to establish a representative view of shadow impacts through the four seasons. Morning (9 AM), noon (12 PM), and afternoon (3 PM) shadows were diagrammed in order to understand the movement of shadows throughout each day.

Solar time was used to calculate the altitude and azimuth of the sun for each time, using geographical data about Charlestown (42'-23" N latitude, 71'-03" W longitude), the day length effects of the elliptical nature of the earth's rotation around the sun, and Daylight Savings Time. These factors result in solar time that can differ from clock time by thirty minutes or more. Daylight Savings Time was taken into account for June and September shadow calculations.

ANALYSIS OF IMPACTS

March 21: March 21 is the Vernal Equinox, the mid-point in the year when day and night are equivalent in length.

March 21/9:00 AM (EST)

At this hour, shadows will be cast from the hotel onto First Avenue reaching to Building 106.

March 21/12:00 Noon (EST)

The hotel continues to cast shadows onto First Avenue at this hour, although the shadows are considerably shorter and only segments of Building 106 are in shadow. Shadows also reach a portion of Sixteenth Street.

March 21/3:00 PM (EST)

Shadows from the hotel at this hour fall on the Aquarium site, and onto a very small portion of the Harborwalk.

June 21: June 21 is the longest day of the year when shadows are shorter than at any other time.

June 21/9:00 AM (EST)

At this hour, shadows from the hotel will be cast onto First Avenue reaching to Building 106.

June 21/12:00 Noon (EST)

The hotel continues to cast shadows onto First Avenue at this hour. The shadows do not reach to Building 106, however, and in fact largely fall only onto the sidewalk in front of the hotel.

June 21/3:00 PM (EST)

Shadows at this hour fall toward the Aquarium site.

September 21: Although September 21 is the Autumnal Equinox, Daylight Savings Time is in effect, and shadows are somewhat longer than they are at the same hour on the Vernal Equinox.

September 21/9:00 AM (DST)

Once again at this early morning hour, shadows fall from the hotel onto First Avenue and Building 106.

September 21/12:00 Noon (DST)

Shadows continue to fall onto First Avenue at this hour.

September 21/3:00 PM (DST)

Shadows fall directly onto the Aquarium site at this hour.

December 21: December 21 is the Winter Solstice when days are shortest, shadows longest, and outdoor activity is generally at a minimum.

December 21/9:00 AM (EST)

Shadows fall from the hotel onto First Avenue, Building 106, and even onto Building 75.

December 21/12:00 Noon (EST)

At this hour, shadows continue to fall onto First Avenue, Building 106, and onto part of Sixteenth Street and part of the Yard's End Park.

December 21/3:00 PM (EST)

The hotel casts shadows to the northeast at this hour fully across the Aquarium site and extending into the Harbor. The Harborwalk is impacted in two locations at this hour: along its easternmost edge and just south of the hotel.

CONCLUSIONS

Every morning throughout the year, First Avenue will be in either partial or full shadow cast by the hotel. Every afternoon, except in the summer, shadows fall onto the Aquarium site. The shadows that fall onto the Aquarium site are primarily located on the entry area of the proposed Aquarium, with somewhat less shadow falling onto the skylit exhibit area. Very little shadow falls onto the Harborwalk from the hotel, and only in the winter do shadows fall onto the Yard's End Park.

MITIGATION

Shadows that fall on First Avenue would fall even with a building of much lesser height, and thus do not warrant mitigation. It should be noted, however, that the massing of the hotel has been planned so that the central wing is set back from the 30-foot edge along First Avenue, so that the gable end portions of the east and west wings are the only taller elements abutting First Avenue. Similarly, the massing has been held back from the Sixteenth Street corridor, thus lessening the shadow impacts that might otherwise have occurred on the Aquarium's entry plaza area and public spaces inside and outside of the proposed Aquarium structure.

ML/jjm/11462/r-hotel

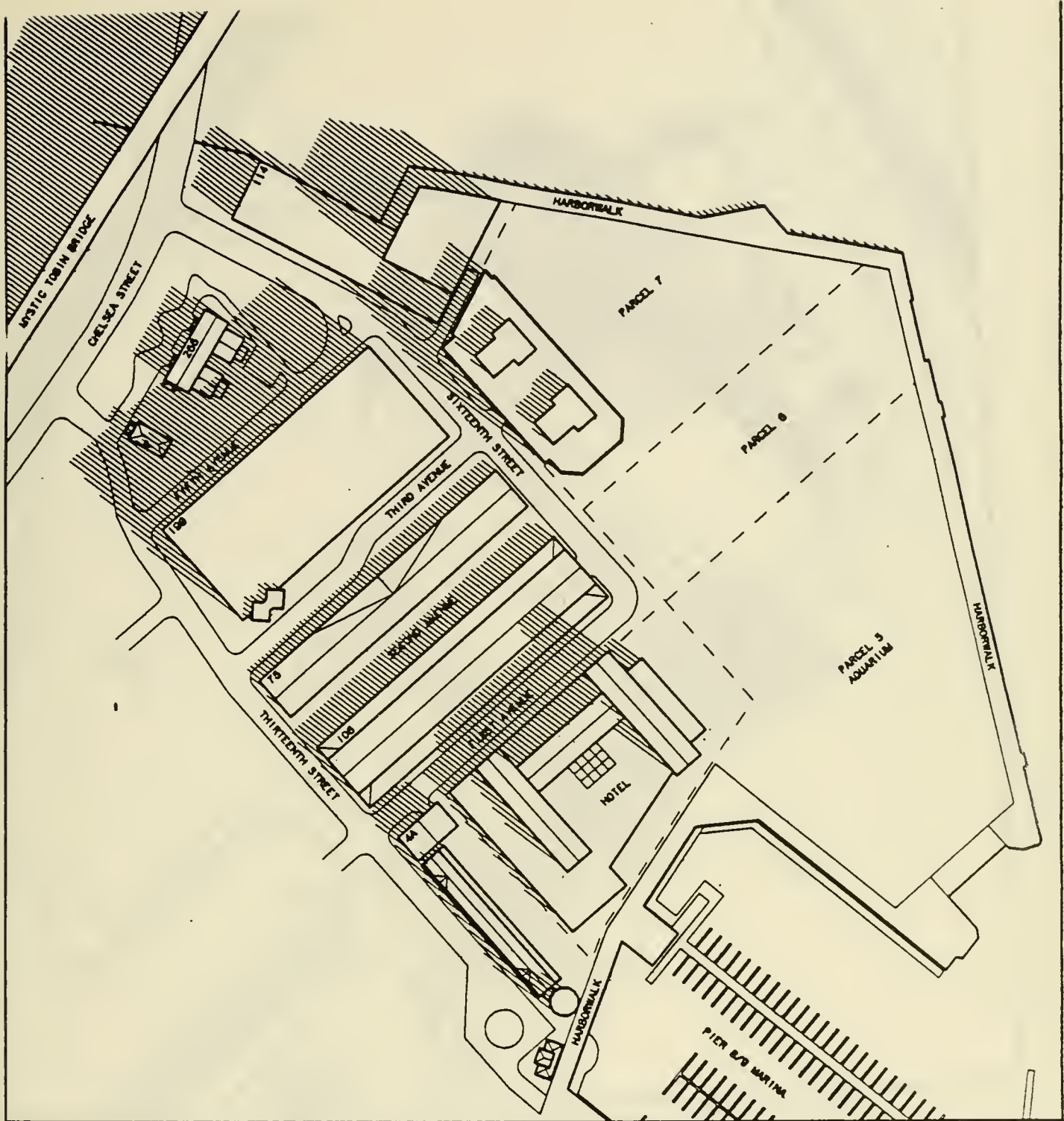


FIGURE: 1 BUILD CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Parcel 4 Hotel

MARCH 21, 9:00 AM
 BEARING: 127
 ALTITUDE: 33



200 0 200
 100 IN FEET



BUILD CONDITION
 SHADOWS

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

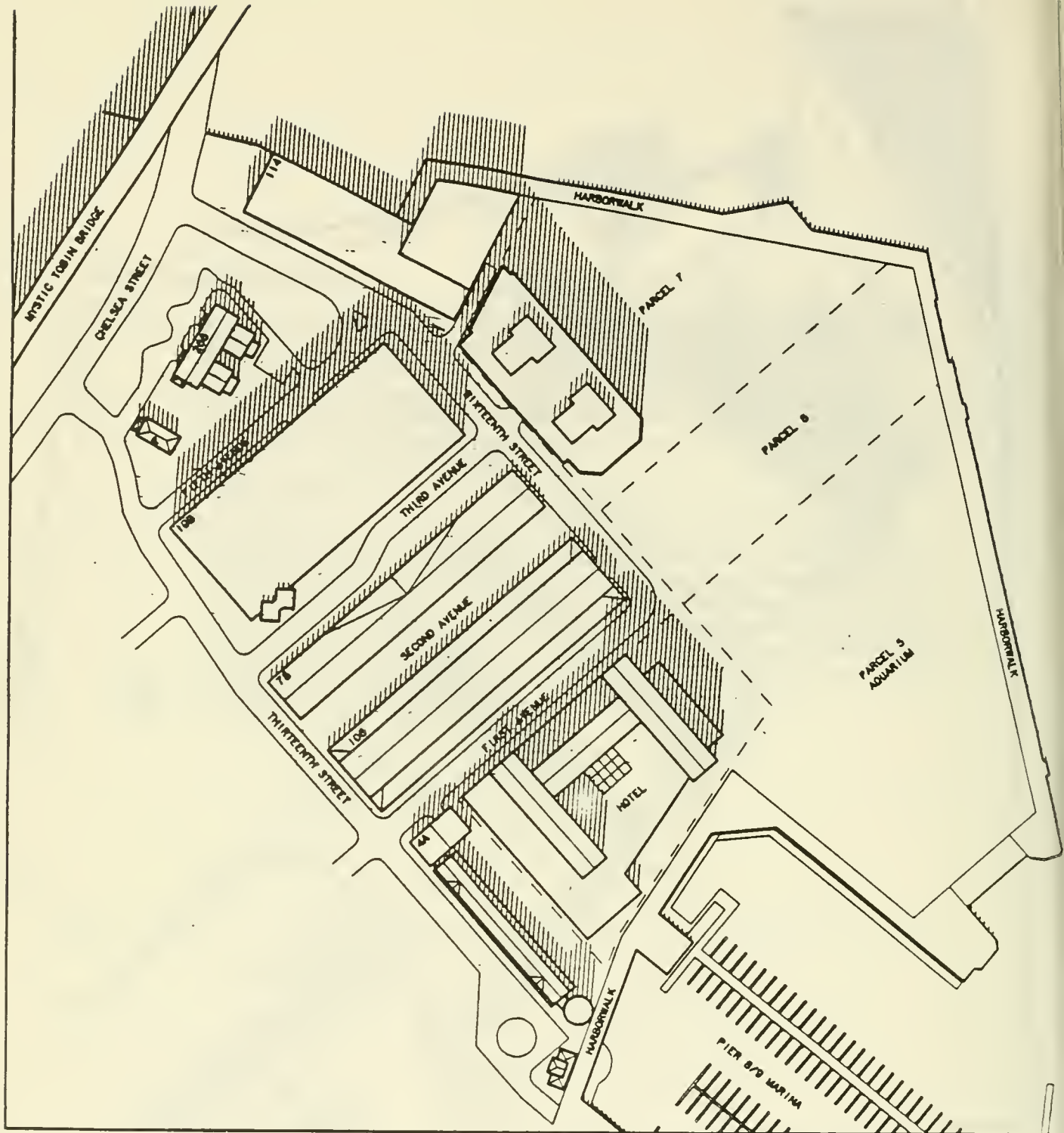


FIGURE: 3 BUILD CONDITIONS SHADOW ANALYSIS
Charlestown Navy Yard
Parcel 4 Hotel

MARCH 21, 12:00 PM
BEARING: 184
ALTITUDE: 48



200 0 200
100 IN FEET



BUILD CONDITION
SHADOWS

PREPARED BY:
SASAKI ASSOCIATES, INC.
64 PLEASANT ST.
WATERTOWN, MA. 02172
30 AUGUST 1991

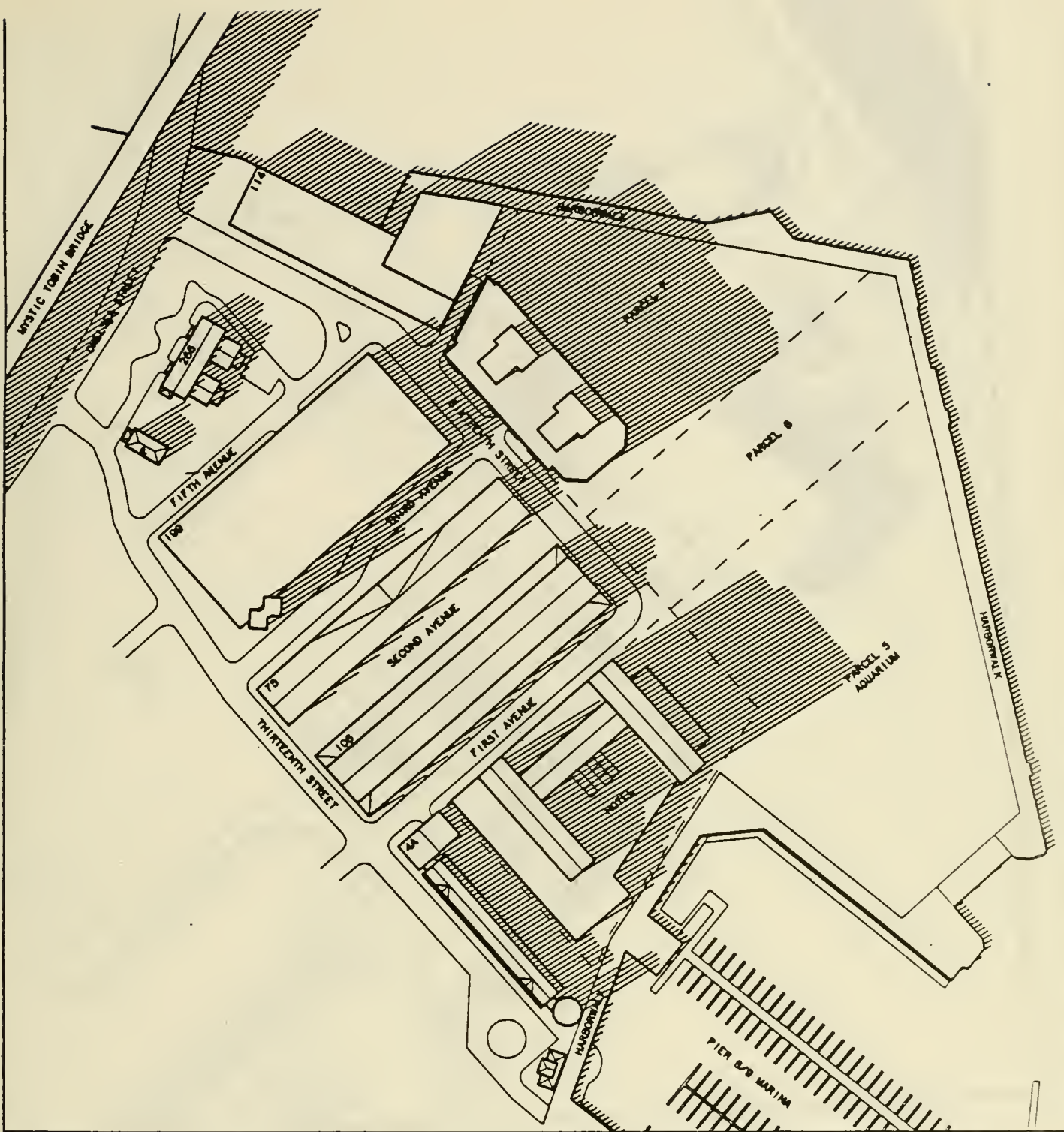


FIGURE: 5 BUILD CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Parcel 4 Hotel

MARCH 21, 3:00 PM
 BEARING: 238
 ALTITUDE: 30



BUILD CONDITION
 SHADOWS

200 0 200
 IN FEET

PREPARED BY:
 SASAKI ASSOCIATES,
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

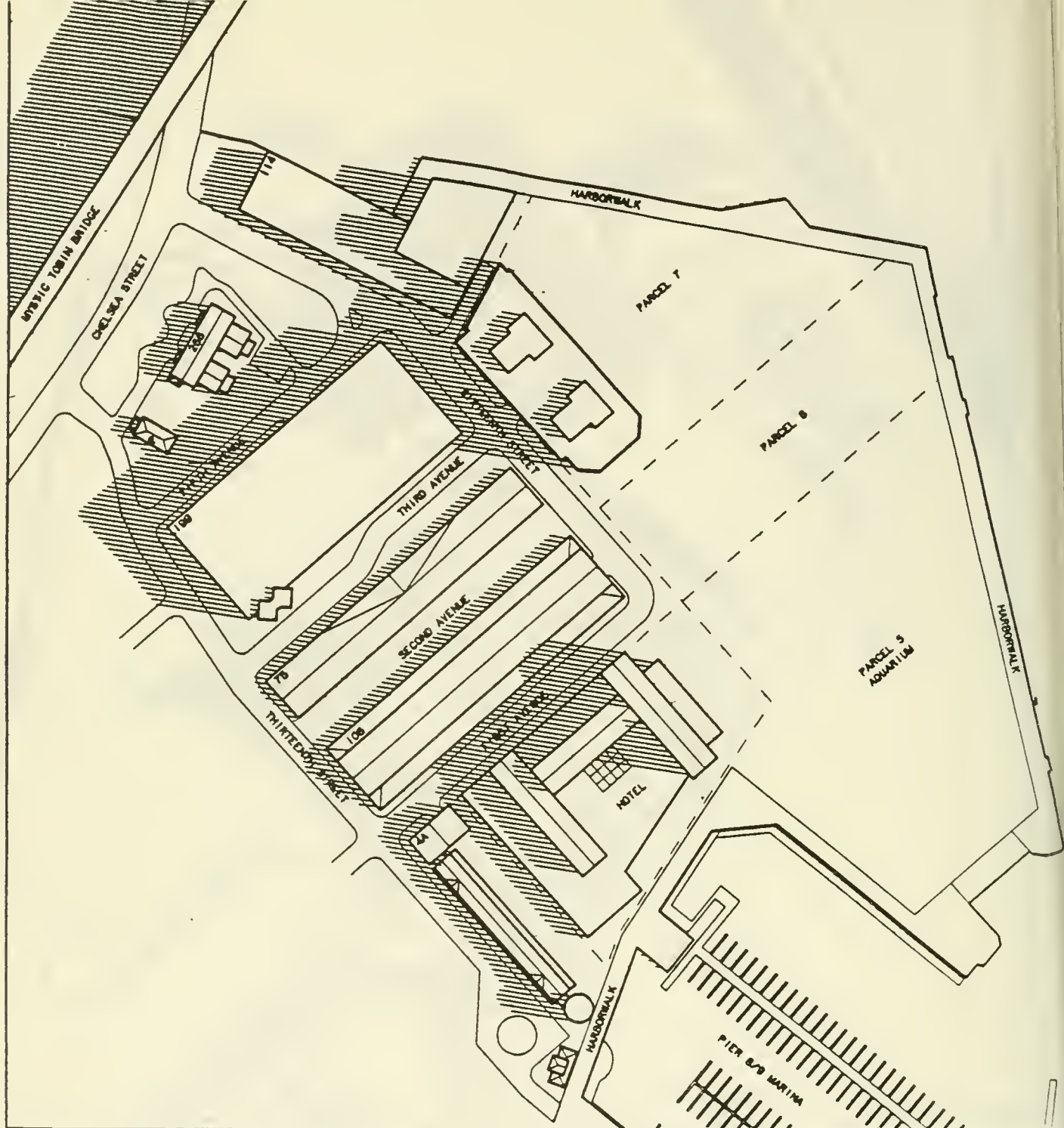


FIGURE: 7 BUILD CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Parcel 4 Hotel

JUNE 21, 9:00 AM
 BEARING: 99
 ALTITUDE: 40



200 0 200
 IN FEET

 BUILD CONDITION SHADOWS

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

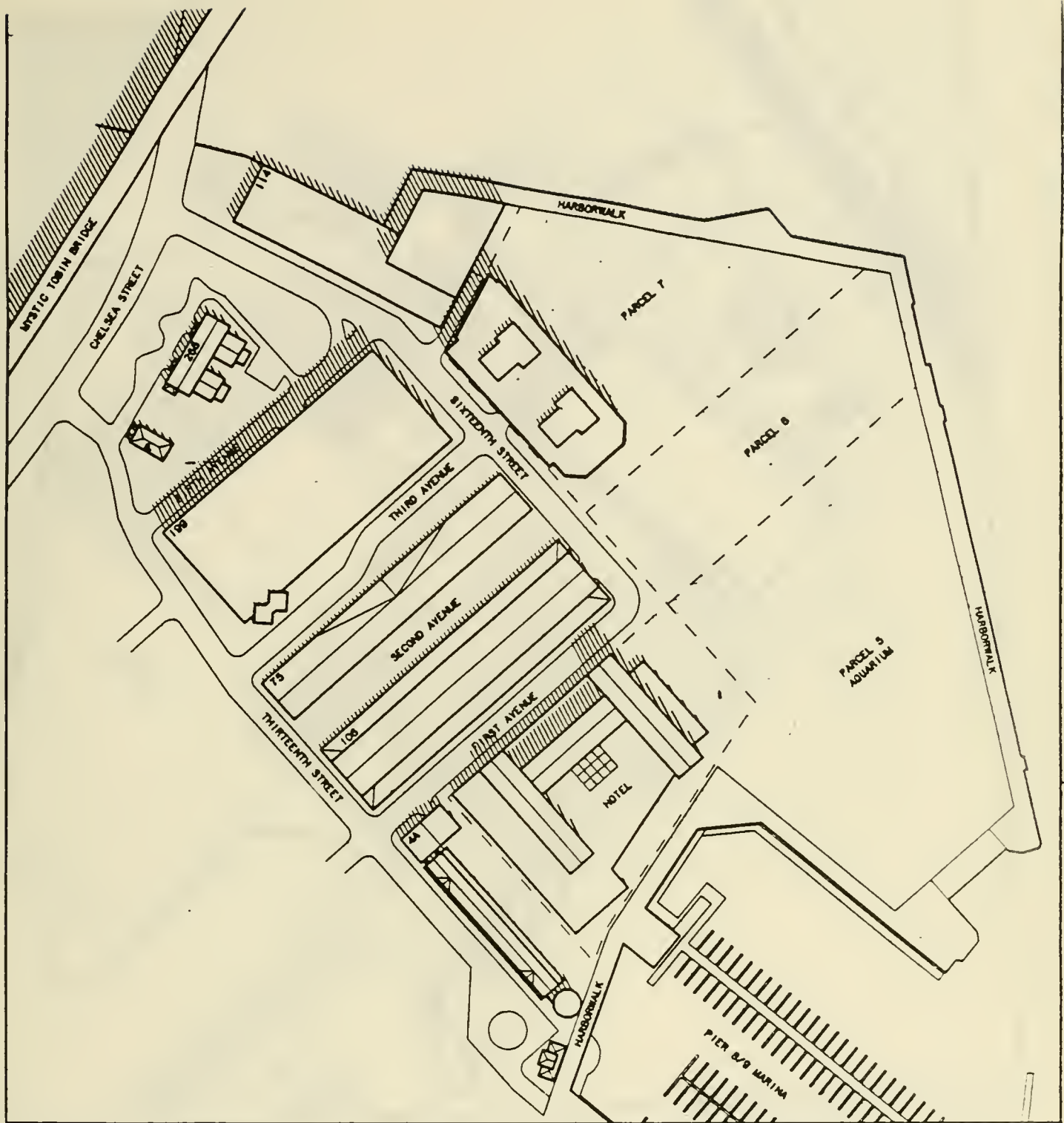


FIGURE: 9 BUILD CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Parcel 4 Hotel

JUNE 21, 12:00 PM
 BEARING: 152
 ALTITUDE: 69



BUILD CONDITION
 SHADOWS

200 0 200
 100 IN FEET

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

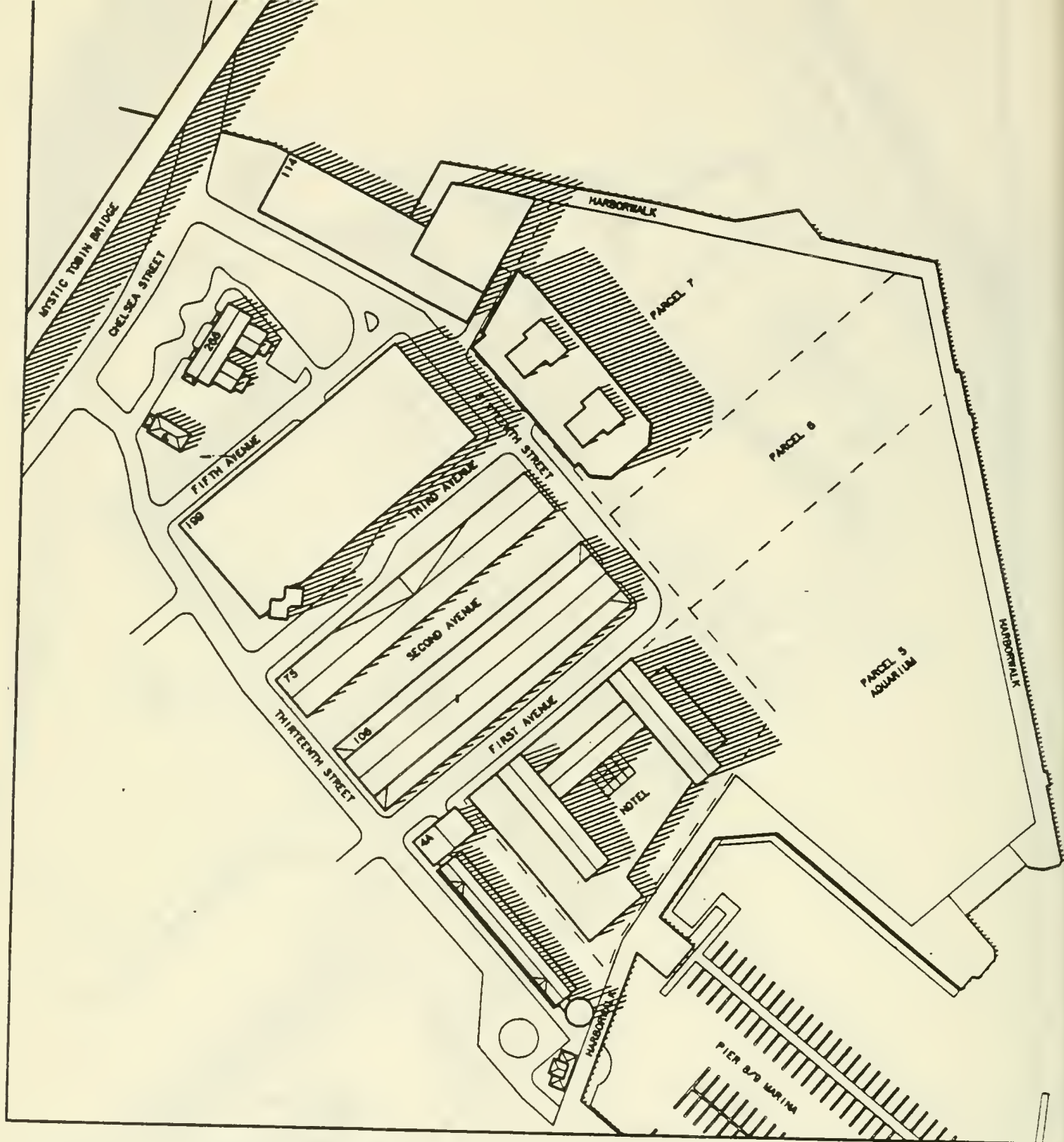
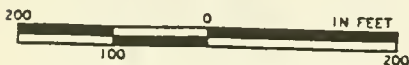


FIGURE: 11 BUILD CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Parcel 4 Hotel

JUNE 21, 3:00 PM
 BEARING: 248
 ALTITUDE: 56



BUILD CONDITION
 SHADOWS



PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

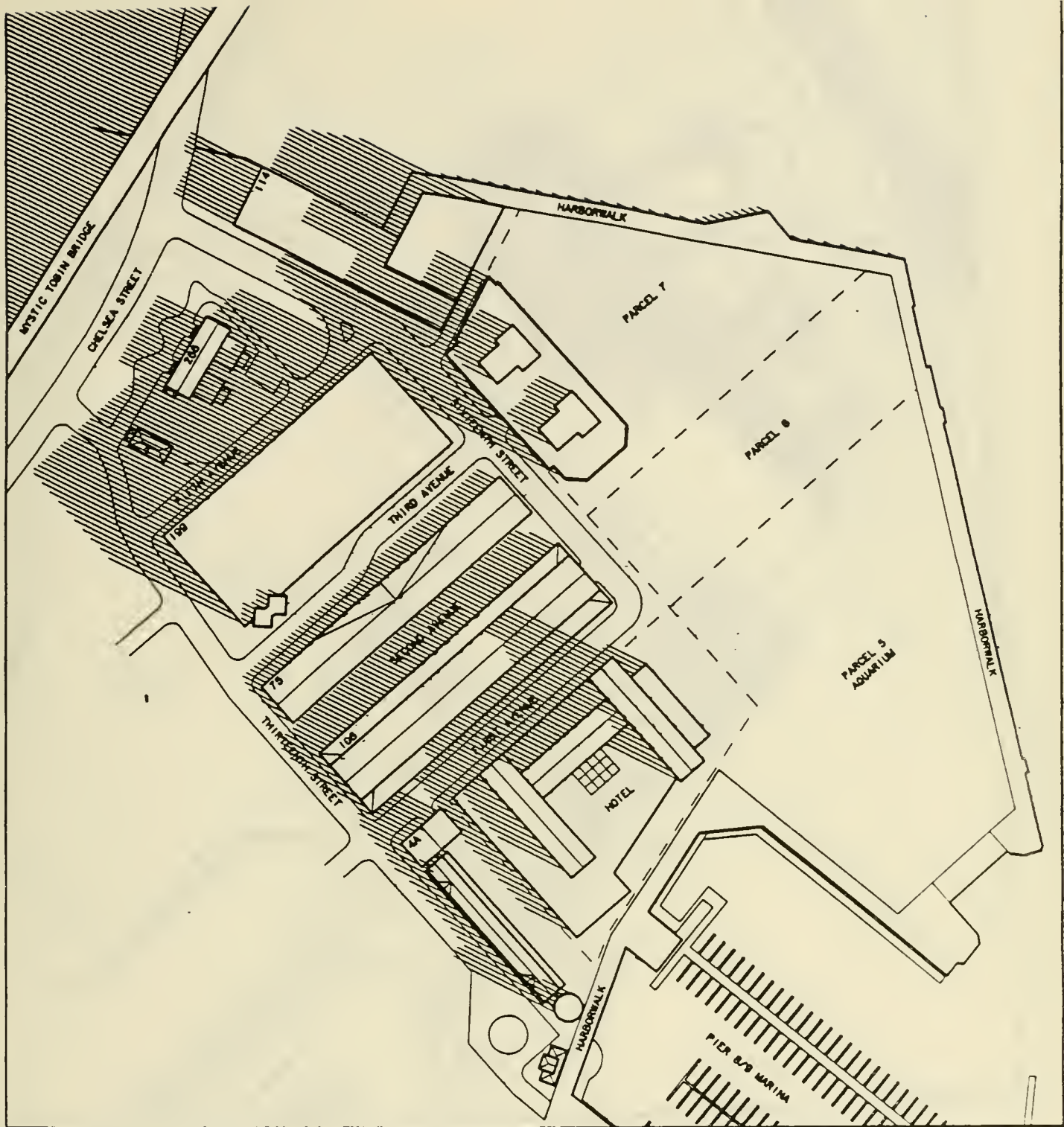


FIGURE: 13 **BUILD CONDITIONS SHADOW ANALYSIS**
 Charlestown Navy Yard
 Parcel 4 Hotel

SEPTEMBER 21, 9:00 AM
 BEARING: 117
 ALTITUDE: 27



**BUILD CONDITION
 SHADOWS**

200 0 200
 IN FEET

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

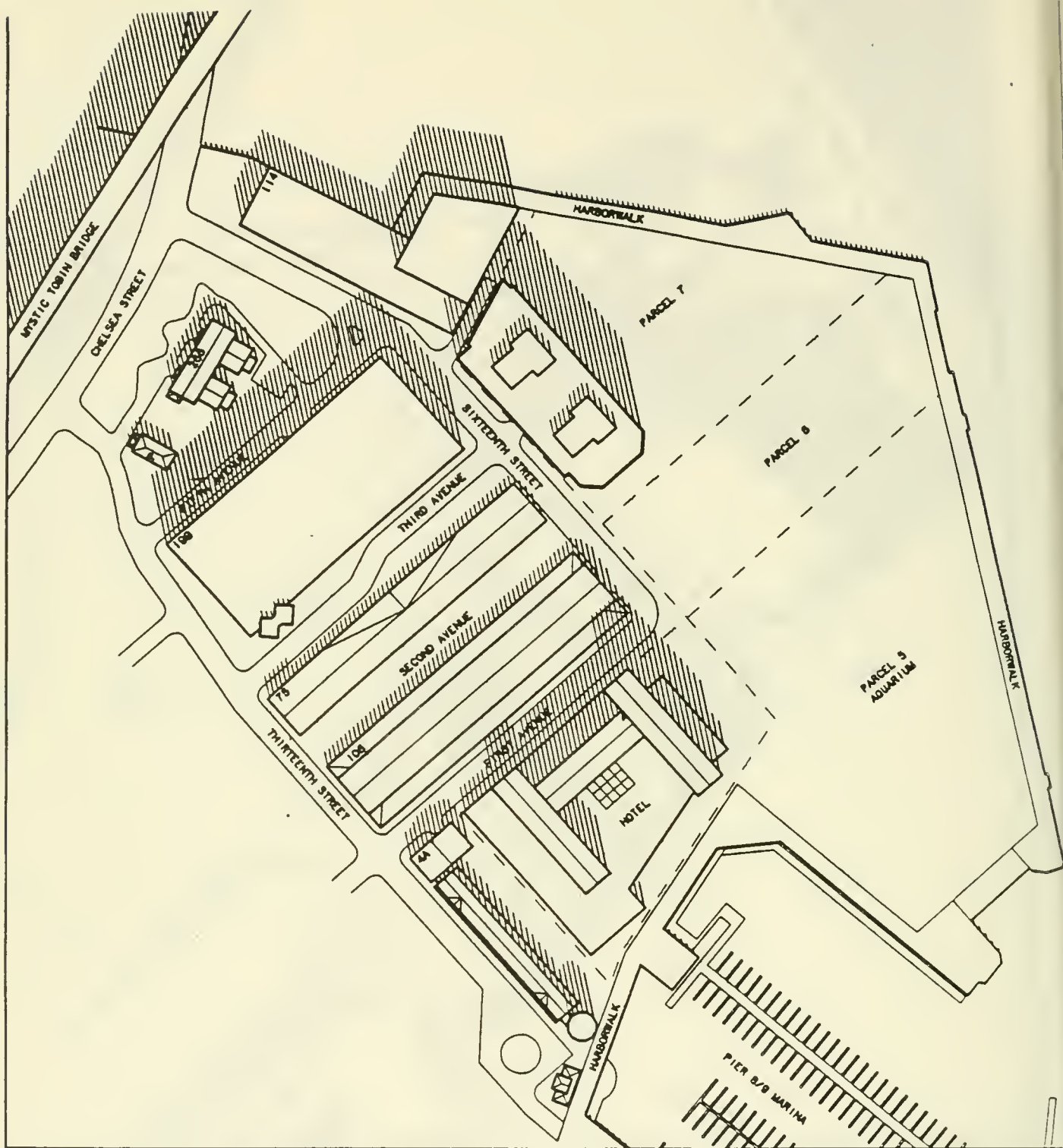


FIGURE: 15 **BUILD CONDITIONS SHADOW ANALYSIS**
Charlestown Navy Yard
Parcel 4 Hotel

SEPTEMBER 21, 12:00 PM
 BEARING: 168
 ALTITUDE: 47



200 0 200
 IN FEET



**BUILD CONDITION
 SHADOWS**

PREPARED BY:
 SASAKI ASSOCIATES, INC
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

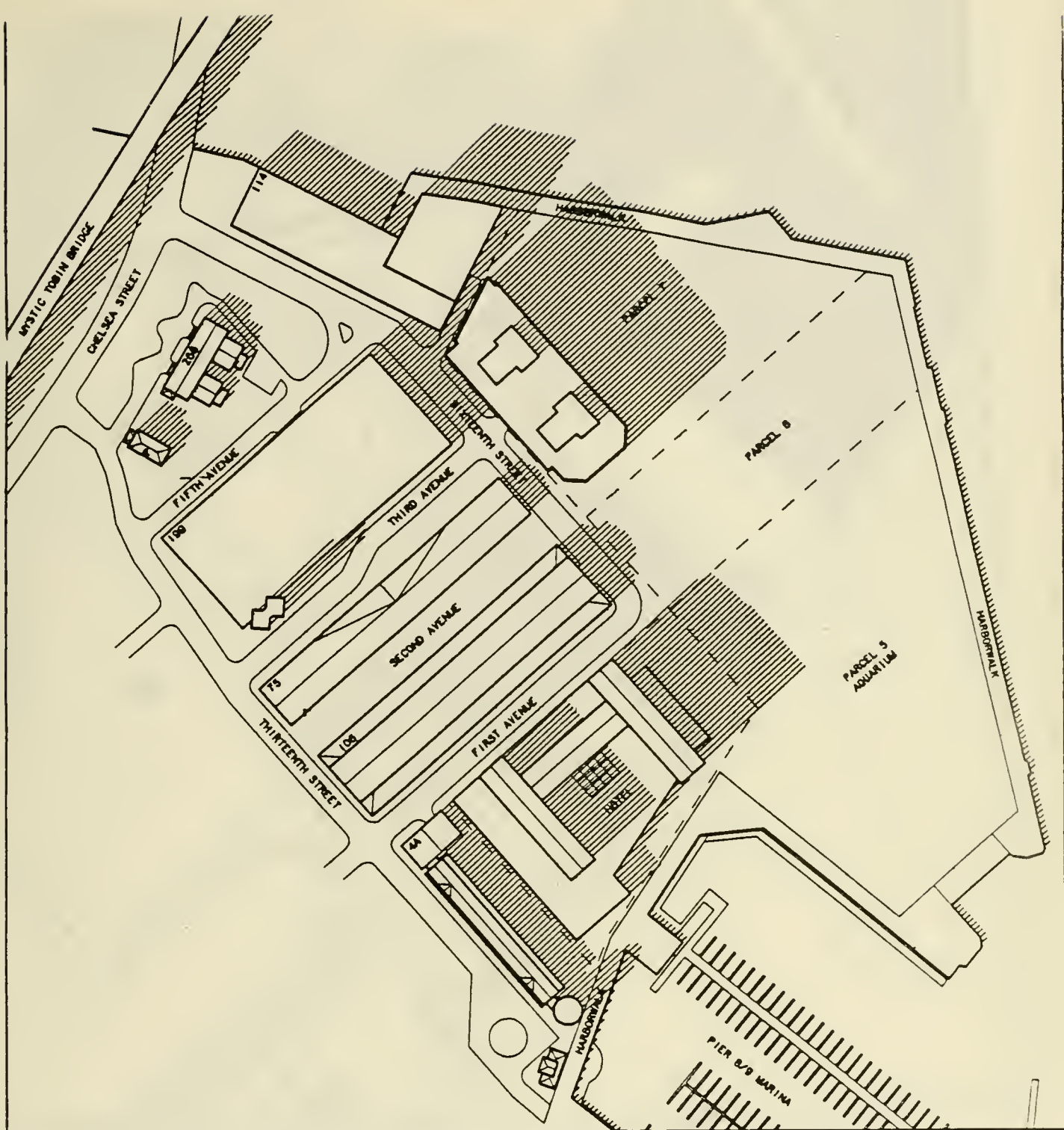


FIGURE: 17 BUILD CONDITIONS SHADOW ANALYSIS
Charlestown Navy Yard
Parcel 4 Hotel

SEPTEMBER 21, 3:00 PM
BEARING: 227
ALTITUDE: 37



BUILD CONDITION
SHADOWS

200 0 200
100 IN FEET

PREPARED BY:
SASAKI ASSOCIATES, INC.
64 PLEASANT ST.
WATERTOWN, MA. 02172
30 AUGUST 1991

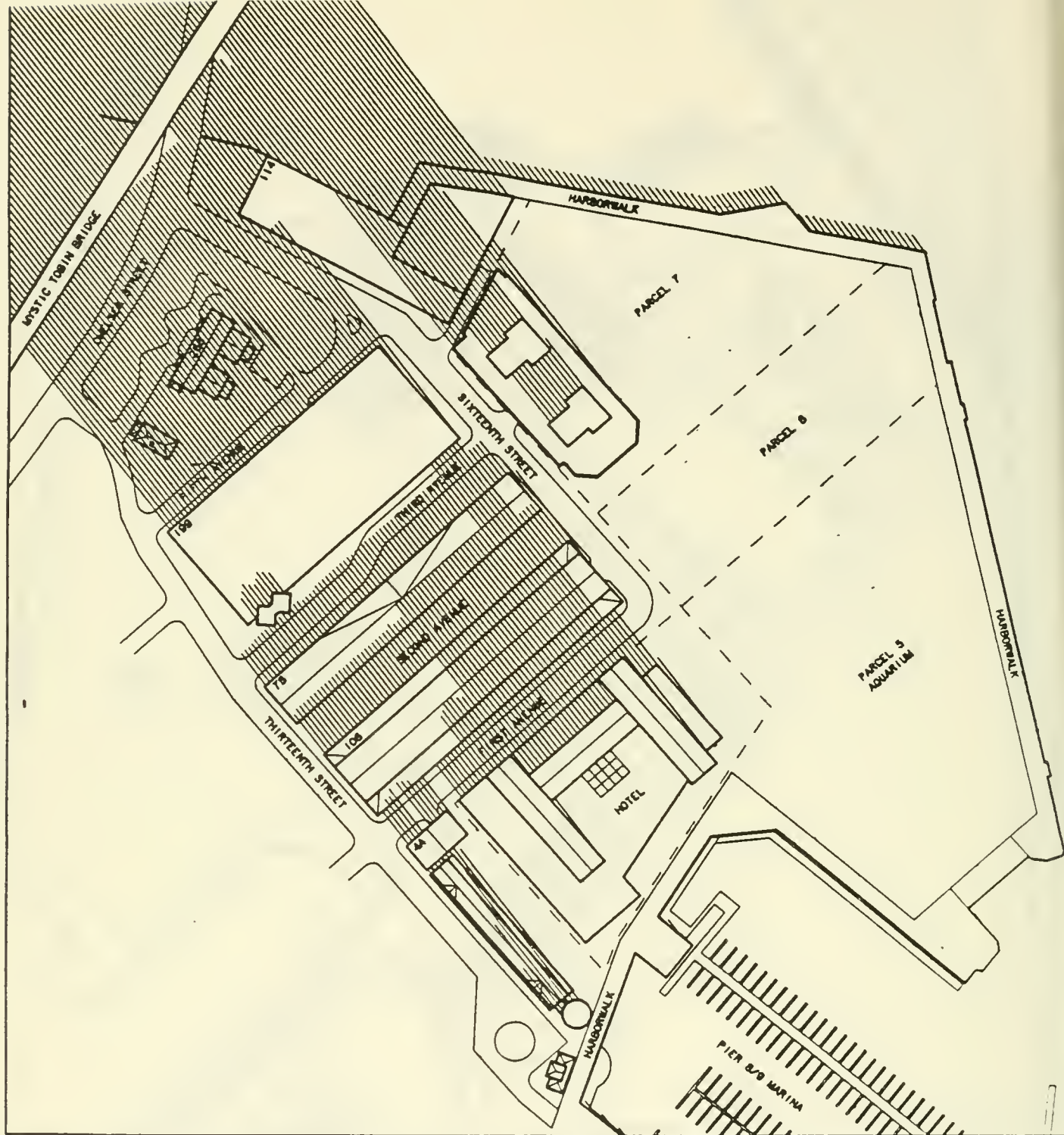


FIGURE: 19 BUILD CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Parcel 4 Hotel

DECEMBER 21, 9:00 AM
 BEARING: 142
 ALTITUDE: 15



BUILD CONDITION
 SHADOWS

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

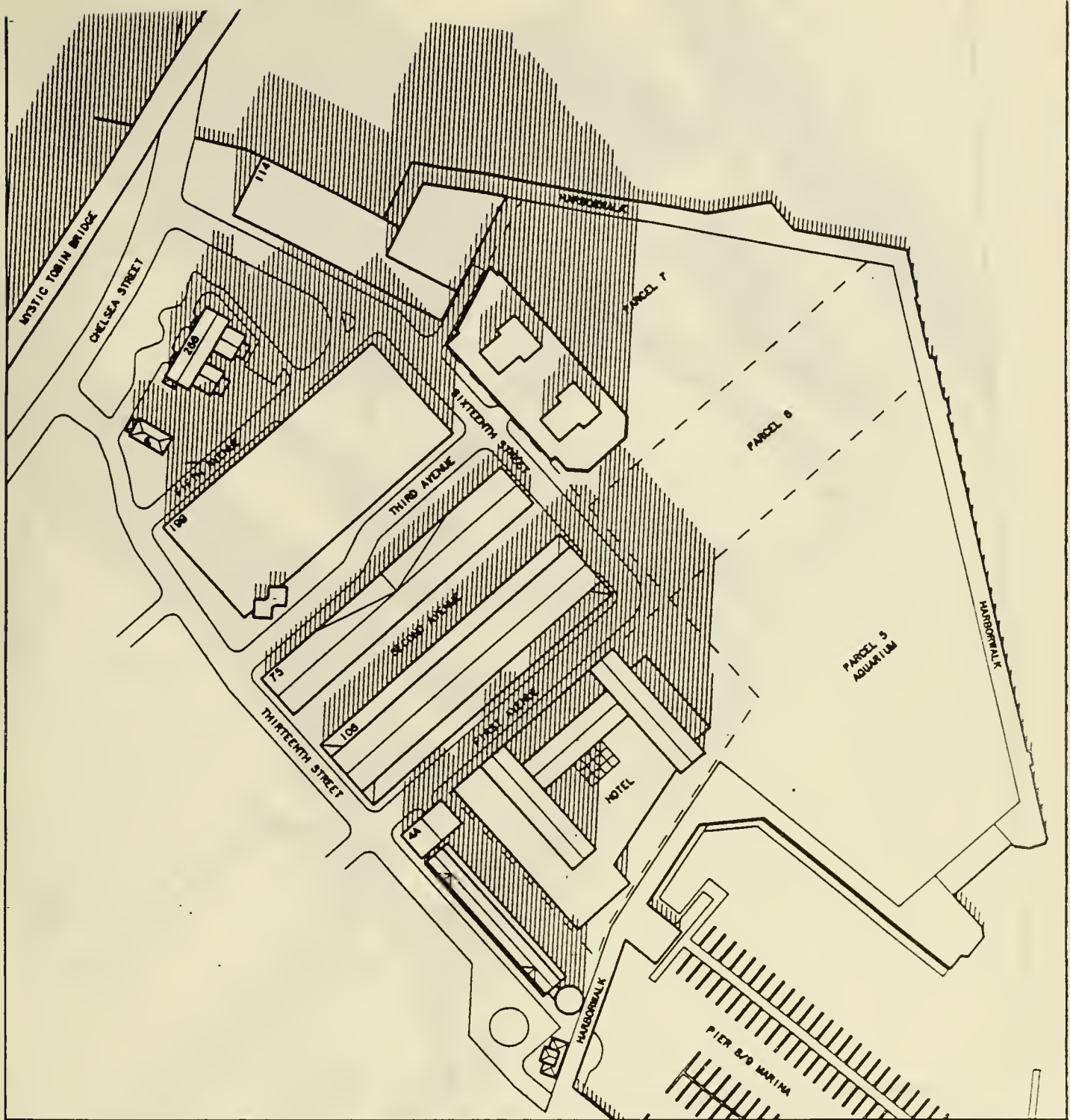


FIGURE: 21 BUILD CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Parcel 4 Hotel

DECEMBER 21, 12:00 PM
 BEARING: 183
 ALTITUDE: 25



200 0 200
 100 IN FEET



BUILD CONDITION
 SHADOWS

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

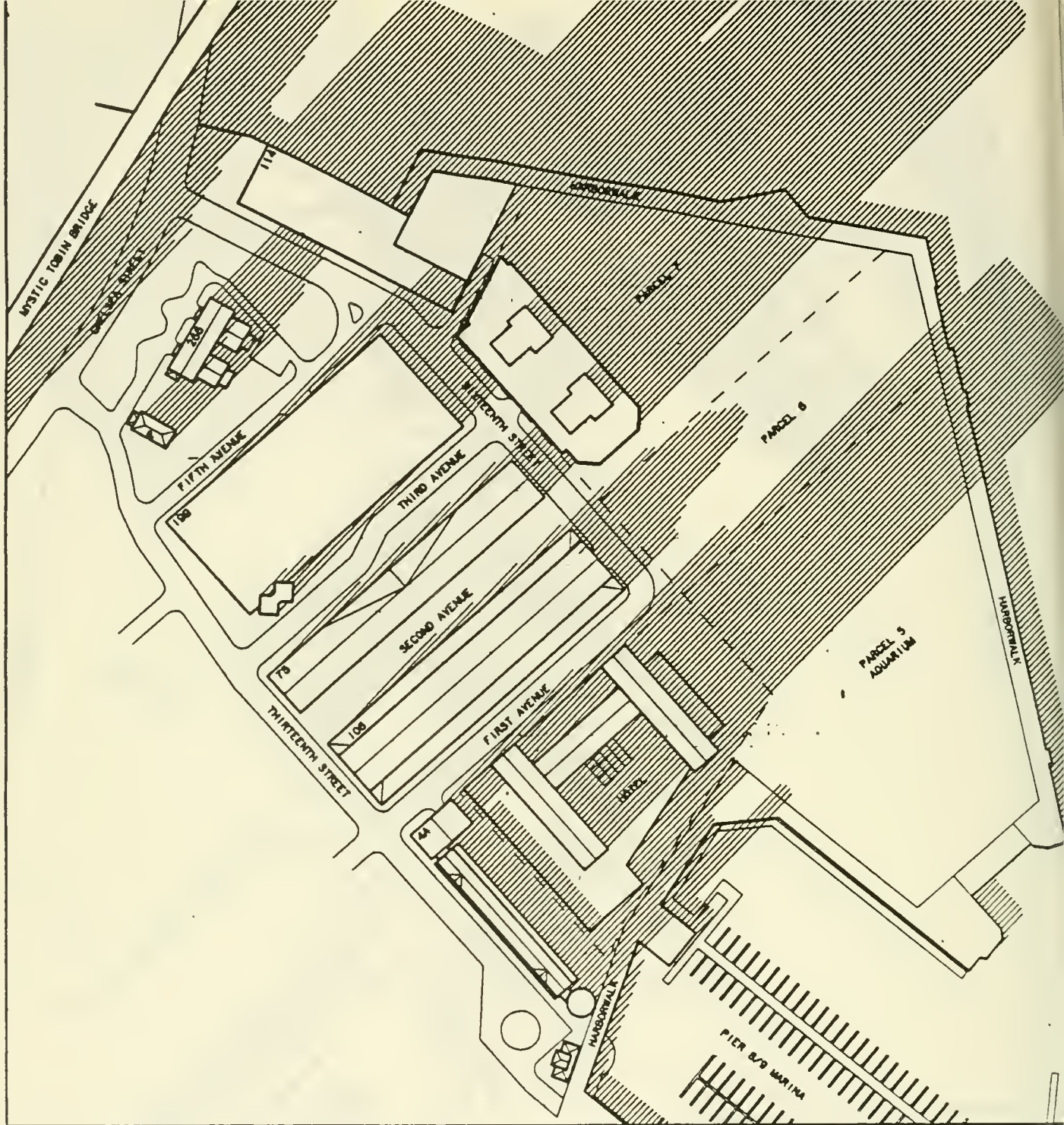


FIGURE: 23 BUILD CONDITIONS SHADOW ANALYSIS
Charlestown Navy Yard
Parcel 4 Hotel

DECEMBER 21, 3:00 PM
BEARING: 224
ALTITUDE: 11



200 0 200
100 IN FEET



BUILD CONDITION
SHADOWS

PREPARED BY:
SASAKI ASSOCIATES, INC.
64 PLEASANT ST.
WATERTOWN, MA. 02172
30 AUGUST 1991

APPENDIX G3

**BUILDINGS B AND C OF THE BIOMEDICAL RESEARCH CENTER
AND THE NEW ENGLAND AQUARIUM**

gov 91-2305

CHARLESTOWN NAVY YARD

**Shadow Analysis of
Biomedical Research Center - Buildings B and C
and The New England Aquarium**

Prepared for: Boston Redevelopment Authority

Prepared by: Sasaki Associates, Inc.

Date: August 19, 1991

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22. Proposed Conditions Shadow Analysis, December 21/12 noon
23. Existing Conditions Shadow Analysis, December 21/3:00 p.m.
24. Proposed Conditions Shadow Analysis, December 21/3:00 p.m.

INTRODUCTION

This study addresses existing conditions and the shadow impacts produced by several buildings proposed for the Charlestown Navy Yard. The proposed buildings included in this analysis are Buildings B and C of the Biomedical Research Center and the New England Aquarium. The study is focused on the impact of these buildings on pedestrian and open space areas in the vicinity. The open space areas upon which shadows may fall include the proposed Harborwalk, the proposed Yard's End Park at the New England Aquarium site, and the pedestrian walkways along Sixteenth Street, Second Avenue, and First Avenue.

EXISTING AND PROPOSED CONDITIONS

The base condition analyzed herein as "existing conditions" includes Buildings 114, 199, 75, 106, and 4A as well as Building A of the Biomedical Research Center, an addition to Building 114, and the hotel located just south of Building 106 on Parcel 4. According to phasing plans for the buildout of the Yard's End area of the Navy Yard, all of these buildings will be completed or occupied when Buildings B and C and The New England Aquarium are built. Therefore, they are all included in the base condition analysis.

The Proposed Project is part of the Charlestown Navy Yard Redevelopment Plan. Uses studied in the Proposed Condition include the following:

Proposed Uses

- Biomedical Research Center Phases B and C consisting of two buildings and located north and east of Building A on Parcels 7 and 6.
- The New England Aquarium at Drydock 5 located south of Buildings A, B and C on Parcel 5.

Pedestrian Areas

- Harborwalk - a continuous pedestrian walkway along the waterfront providing a pedestrian link between the USS Constitution and the Aquarium and other Navy Yard uses, and extending to the perimeter of the Little Mystic Channel.
- Yard's End Park - a park space and plaza located between the Aquarium, Building A, and Building C, at the end of First Avenue on Parcels 5 and 6.
- Sixteenth Street - a secondary auto and pedestrian route.
- Second Avenue - a major pedestrian axis for the Navy Yard Redevelopment area starting at Fifth Street and extending to the Biomedical Research Center and Yards' End Park.
- First Avenue - a major auto and pedestrian route.

METHODOLOGY

Shadows were projected for Buildings B and C and for the New England Aquarium on four (4) key days of the year: March 21, June 21, September 21, and December 21 to establish a representative view of shadow impacts through the four seasons. Morning (9 AM), noon (12 PM), and afternoon (3 PM) shadows were diagrammed in order to understand the movement of shadows throughout each day.

Solar time was used to calculate the altitude and azimuth of the sun for each time, using geographical data about Charlestown (42°-23' N latitude, 71°-03' W longitude), the day length effects of the elliptical nature of the earth's rotation around the sun, and Daylight Savings Time. These factors result in solar time that can differ from clock time by thirty minutes or more. Daylight Savings Time was taken into account for June and September shadow calculations.

Graphics were prepared to show (1) existing condition shadows and (2) shadows of the Proposed Condition, and are intended to give a general understanding of shadow impact areas (See Figures 1 to 24).

ANALYSIS OF IMPACTS

March 21: March 21 is the Vernal Equinox, the mid-point in the year when day and night are equivalent in length.

March 21/9:00 AM (EST). (See Figures 1 and 2.)

Shadows from Buildings B and C will be cast on nearly the entire length of the northernmost segment of the Harborwalk on this day. As can be seen in the figures which illustrate conditions in the fall and winter, this northern section of the Harborwalk will be in shadow during those seasons as well. Building C also casts a shadow on a portion of the Biomedical Research Center entry plaza. The Aquarium will cast some shadow on the Yard's End Park and on its own entry plaza.

March 21/12:00 Noon (EST). (See Figures 3 and 4.)

The northernmost section of the Harborwalk continues to be in shadow at this hour.

A small area of shadow will be cast by the Aquarium on its entry plaza.

March 21/3:00 PM (EST). (See Figures 5 and 6.)

At this hour, most of the northern and eastern sections of the Harborwalk are in shadow from the Biomedical Research Center and the Aquarium.

June 21: June 21 is the longest day of the year when shadows are shorter than at any other time.

June 21/9:00 AM (DST). (See Figures 7 and 8.)

Shadows will be cast by Building C and by the Aquarium on each of their respective entry plazas. This is the one time of the year when shadows are not cast on the northern section of the Harborwalk.

June 21/12:00 Noon (DST). (See Figures 9 and 10.)

Buildings B and C will cast some shadow on the northernmost section of the Harborwalk.

June 21/3:00 PM (DST). (See Figures 11 and 12.)

Buildings B and C continue to cast shadows on the northernmost section of the Harborwalk at this hour.

September 21: Although September 21 is the Autumnal Equinox, Daylight Savings Time is in effect, and shadows are somewhat longer than they are at the same hour on the Vernal Equinox.

September 21/9:00 AM (DST). (See Figures 13 and 14.)

Shadows will be cast from Buildings B and C on nearly the entire length of the northernmost section of the Harborwalk. Building C will cast shadow on its entry plaza.

The Aquarium will cast shadow on its entry plaza.

September 21/12:00 Noon (DST). (See Figures 15 and 16.)

The northern section of the Harborwalk continues to be in shadow at this hour.

Shadows continue to exist but are diminished on the Aquarium entry plaza.

September 21/3:00 PM (DST). (See Figures 17 and 18.)

The northern section of the Harborwalk continues in shadow at this hour, as are small portions of the eastern section of the Harborwalk.

December 21: December 21 is the Winter Solstice when days are shortest, shadows longest, and outdoor activity is generally at a minimum.

December 21/9:00 AM (EST). (See Figures 19 and 20.)

As at other times of the year, the northern section of the Harborwalk is in shadow.

The Aquarium will cast shadows on its entry plaza.

December 21/12:00 Noon (EST). (See Figures 21 and 22.)

The northern section of the Harborwalk continues in shadow.

The Aquarium continues to cast shadow on its entry plaza.

December 21/3:00 PM (EST). (See Figures 23 and 24.)

All of the northern and eastern sections of the Harborwalk will be in shadow at this hour.

CONCLUSIONS

Shadows cast by Buildings B and C of the Biomedical Research Center will put the northernmost section of the Harborwalk in shadow most days of the year. In the early morning throughout the year, Building C casts some shadow on the entry plaza of the Biomedical Research Center.

The New England Aquarium casts some shadow in the late afternoon on the eastern portion of the Harborwalk. The Aquarium also casts shadow on its entry plaza in the morning hours throughout the year.

It is important to note that the Yard's End Park remains very sunny except in the early morning hours and during winter months. It is also significant that the portion of the Harborwalk on the westerly side of Pier 10 is never in shadow at the hours illustrated. The only time it will be in shadow is in the very early morning hours in the early summer. Also, there are no shadow impacts on either First Avenue, Second Avenue, or Sixteenth Street from these buildings.

MITIGATION

The only pedestrian area that will be significantly impacted by shadow is the northernmost end of the Harborwalk. Since this end is not expected to be an area of high activity, and since even a one story building in this location would cause similar results, this impact seems inevitable.

Of secondary importance is the entry plaza of the New England Aquarium. While shadows on the northern side of any building are to be expected and changes in building design are not appropriate, it will be important during the winter months to keep the entry walkways free of ice since the sun will not have a chance to melt it.

ML/jjm/11462/r-neacqu

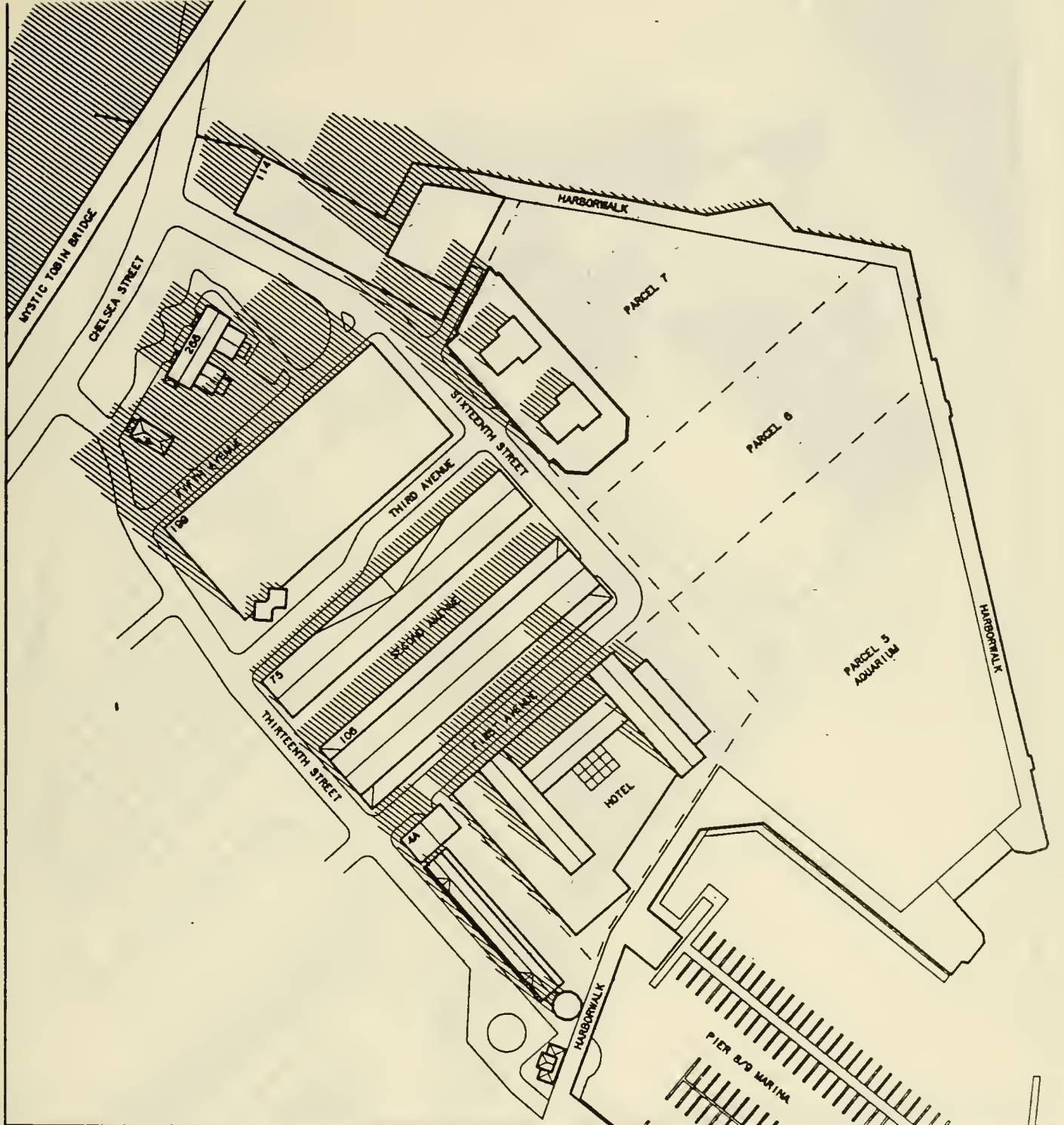


FIGURE: 1

BASE CONDITIONS SHADOW ANALYSIS

Charlestown Navy Yard

Biomedical Research Center – Buildings B & C

and New England Aquarium

MARCH 21, 9:00 AM
 BEARING: 127
 ALTITUDE: 33



BASE CONDITION
 SHADOWS

200 0 200
 100 IN FEET

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

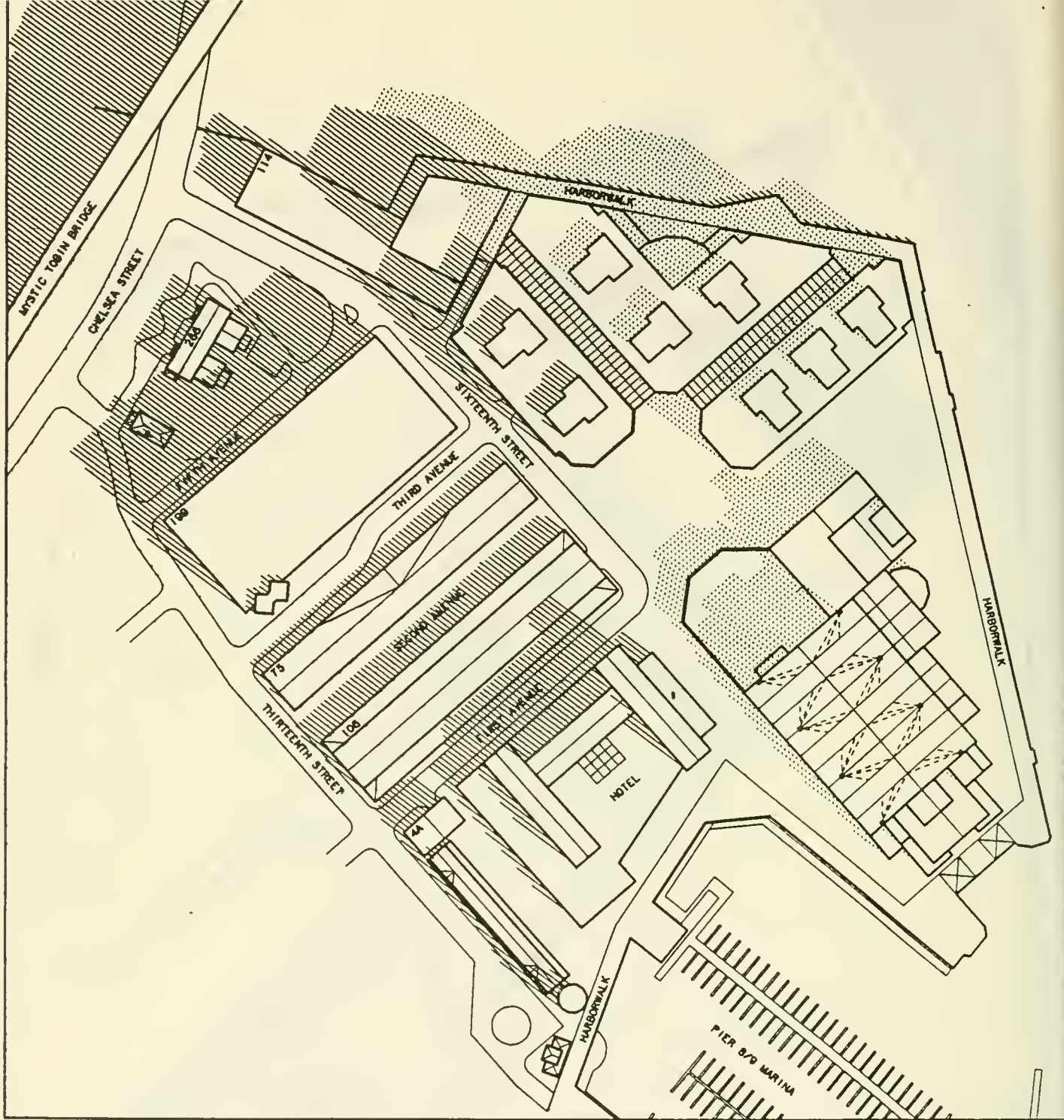


FIGURE: 2 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center – Buildings B & C
 and New England Aquarium

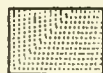
MARCH 21, 9:00 AM
 BEARING: 127
 ALTITUDE: 33



200 0 200
 IN FEET



BASE CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL B & C,
 NEW ENGLAND AQUARIUM)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

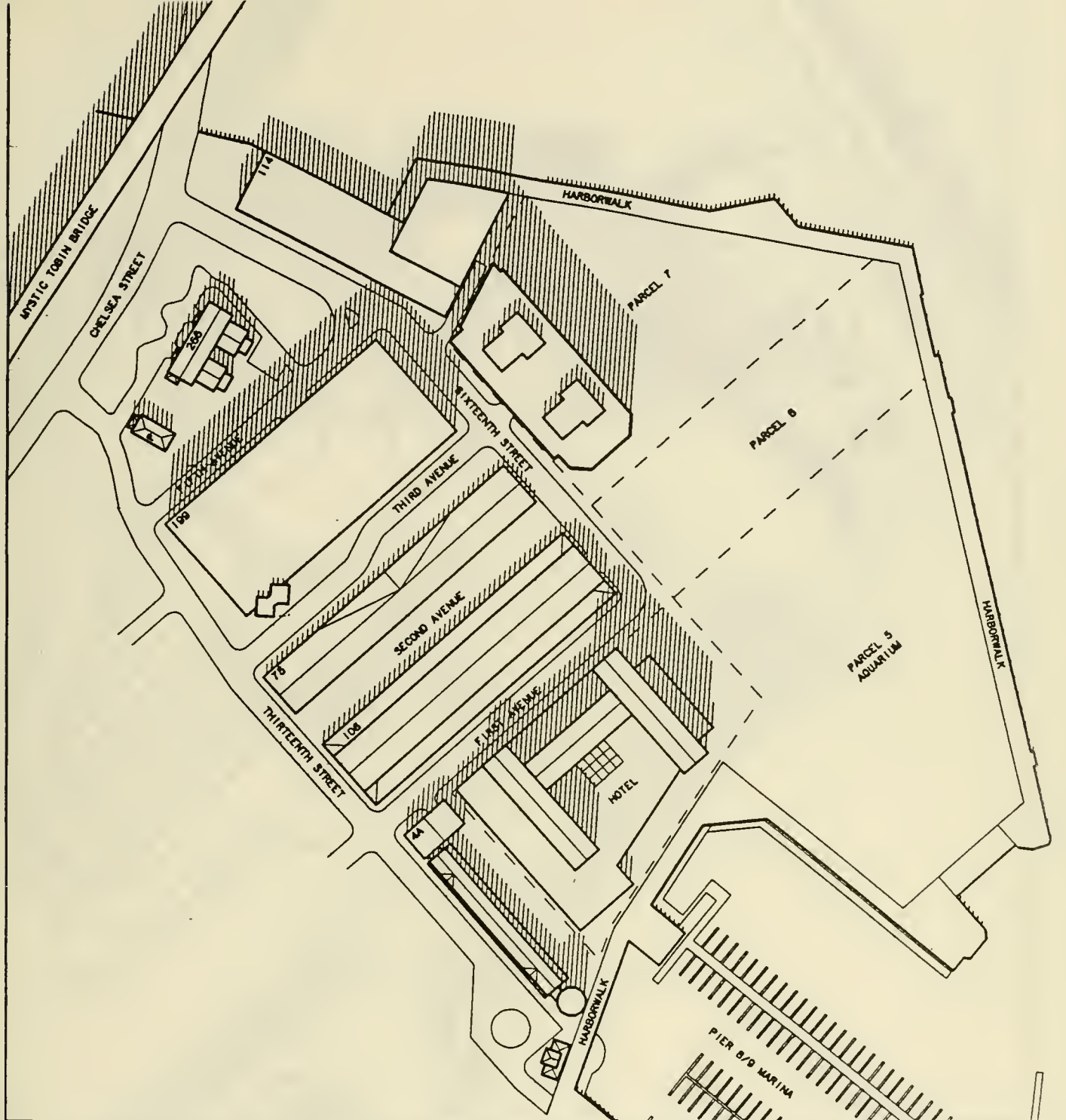


FIGURE: 3

BASE CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center – Buildings B & C and New England Aquarium

MARCH 21, 12:00 PM
 BEARING: 184
 ALTITUDE: 48



BASE CONDITION
 SHADOWS

200 0 200
 IN FEET
 100

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

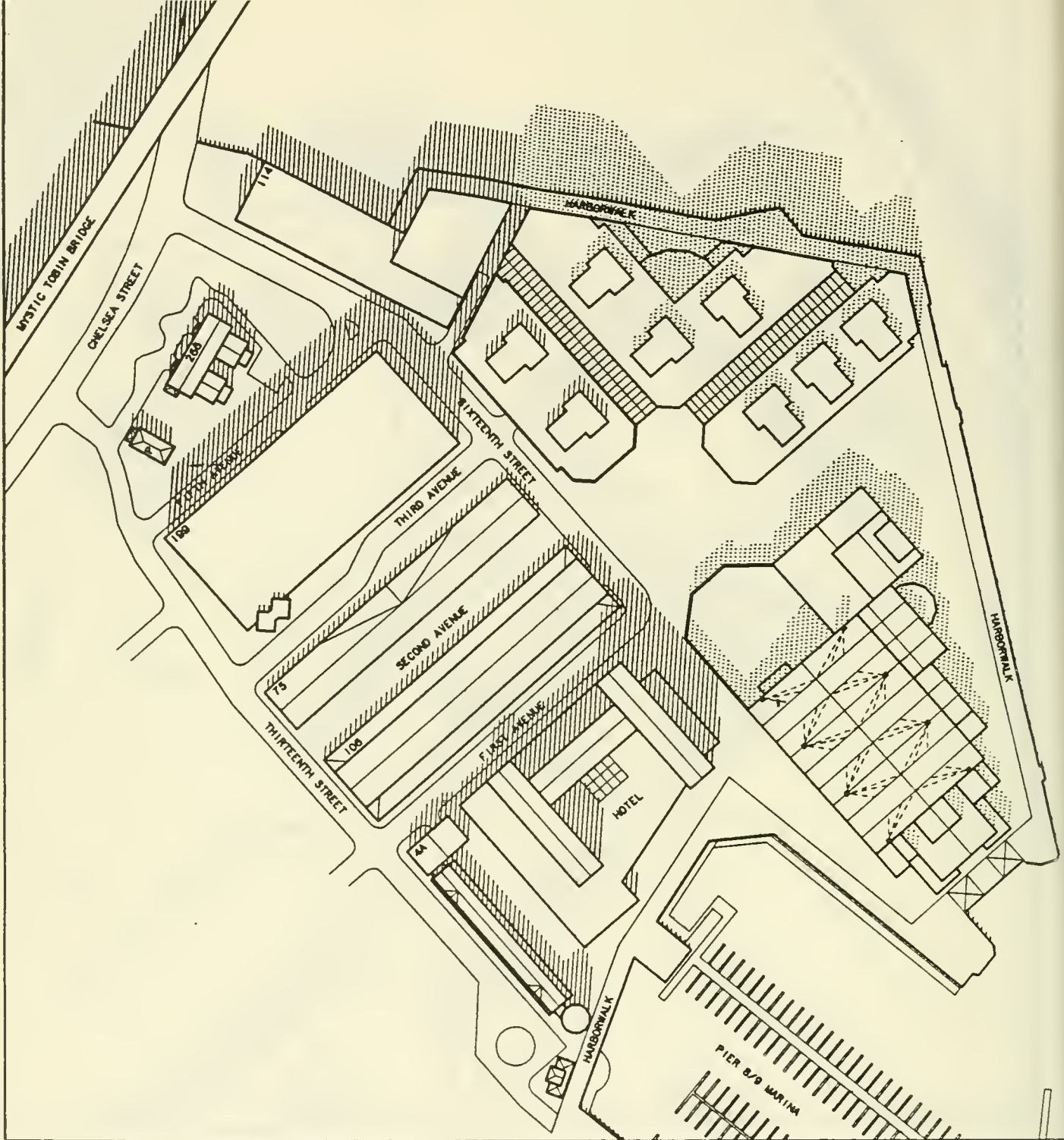


FIGURE: 4 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center – Buildings B & C
 and New England Aquarium

MARCH 21, 12:00 PM
 BEARING: 184
 ALTITUDE: 48



200 0 IN FEET
 100 200



BASE CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL B & C,
 NEW ENGLAND AQUARIUM)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

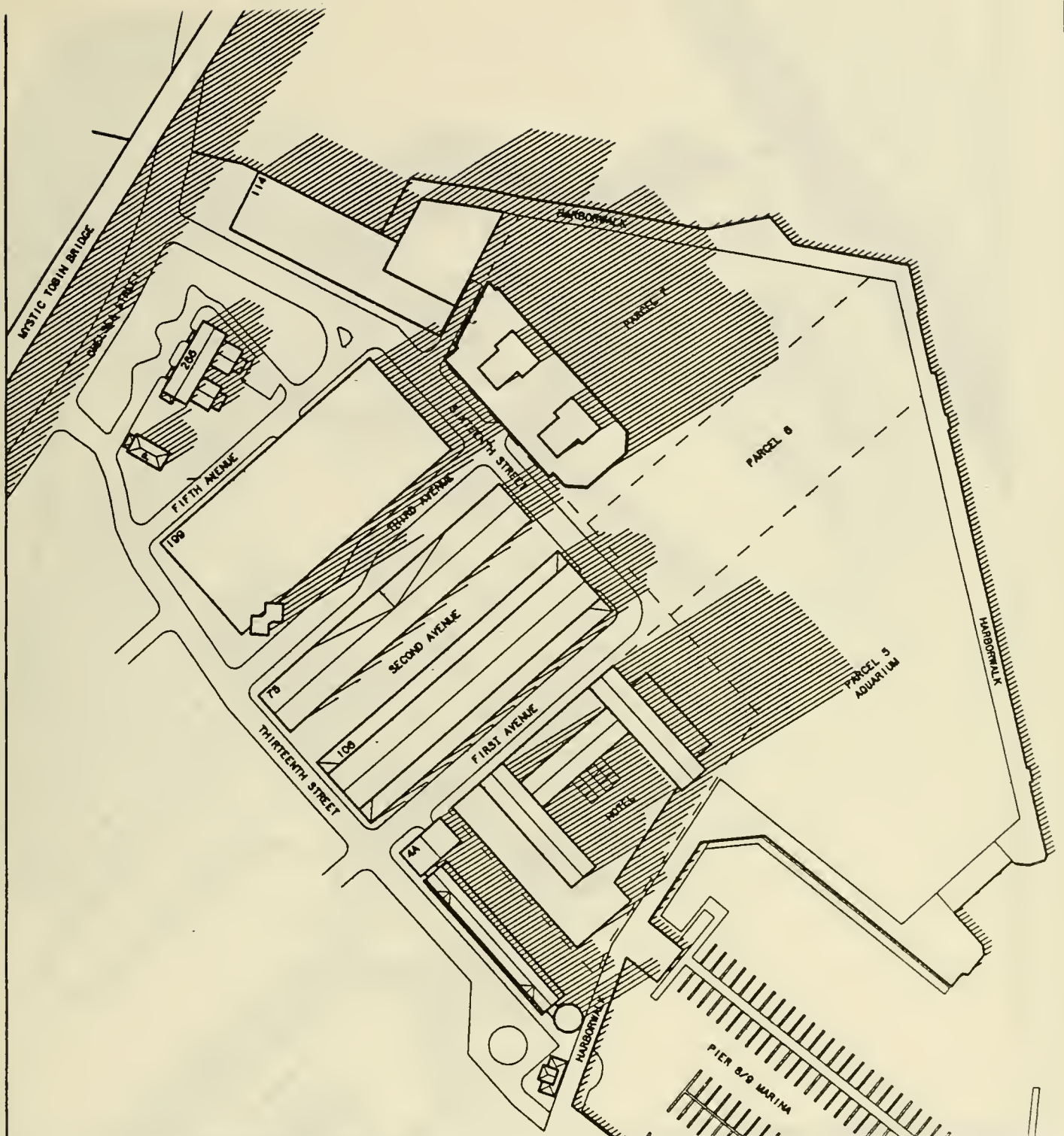


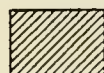
FIGURE: 5

BASE CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center - Buildings B & C
 and New England Aquarium

MARCH 21, 3:00 PM
 BEARING: 238
 ALTITUDE: 30



200 0 200
 IN FEET
 100



BASE CONDITION
 SHADOWS

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

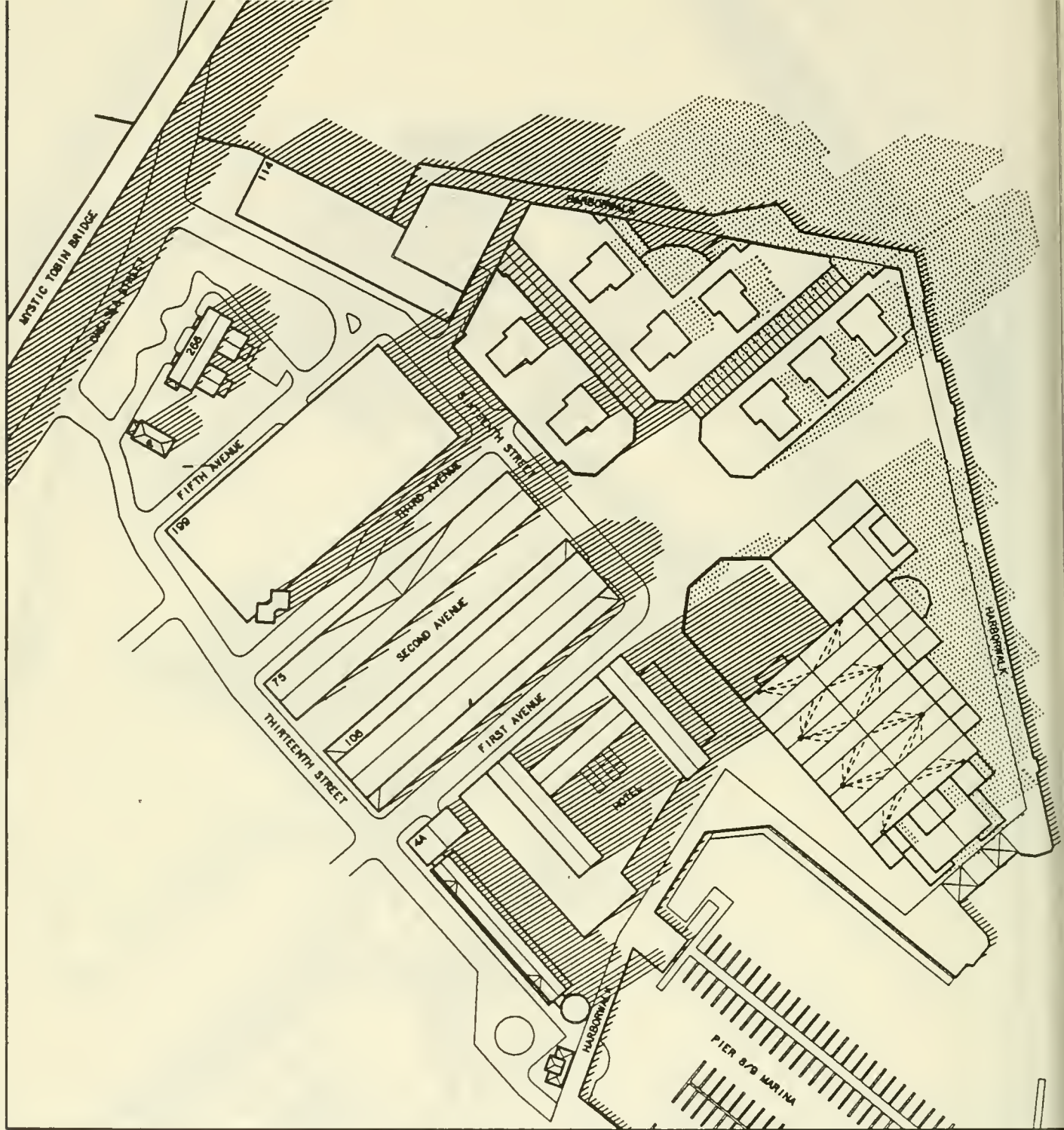


FIGURE: 6 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center – Buildings B & C
 and New England Aquarium

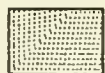
MARCH 21, 3:00 PM
 BEARING: 238
 ALTITUDE: 30



200 0 200
 IN FEET



BASE CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL B & C,
 NEW ENGLAND AQUARIUM)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

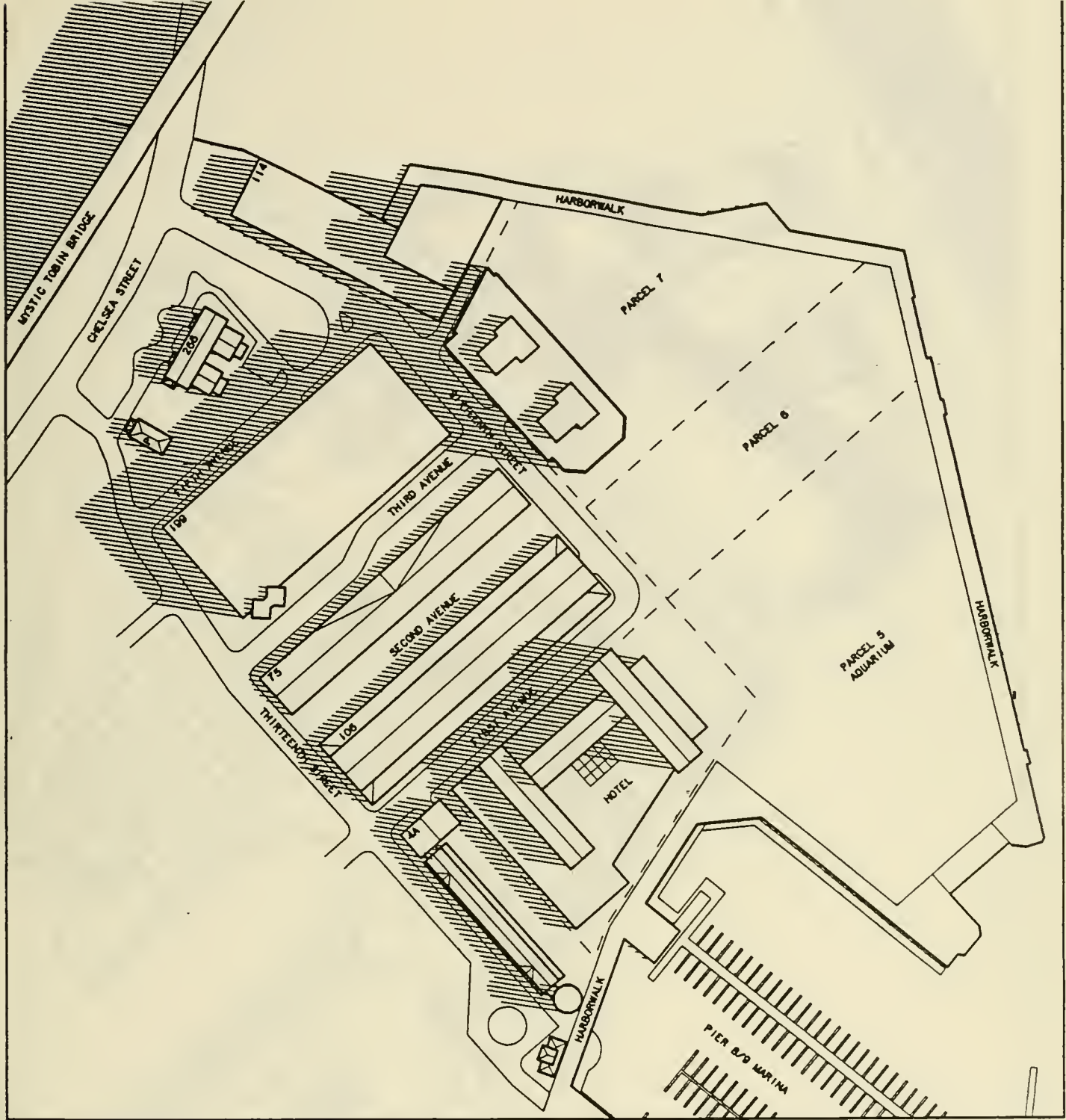


FIGURE: 7

BASE CONDITIONS SHADOW ANALYSIS

Charlestown Navy Yard

Biomedical Research Center - Buildings B & C

and New England Aquarium

JUNE 21, 9:00 AM
BEARING: 99
ALTITUDE: 40



BASE CONDITION
SHADOWS

200 0 200
100 IN FEET

PREPARED BY:
SASAKI ASSOCIATES, INC.
64 PLEASANT ST.
WATERTOWN, MA. 02172
30 AUGUST 1991

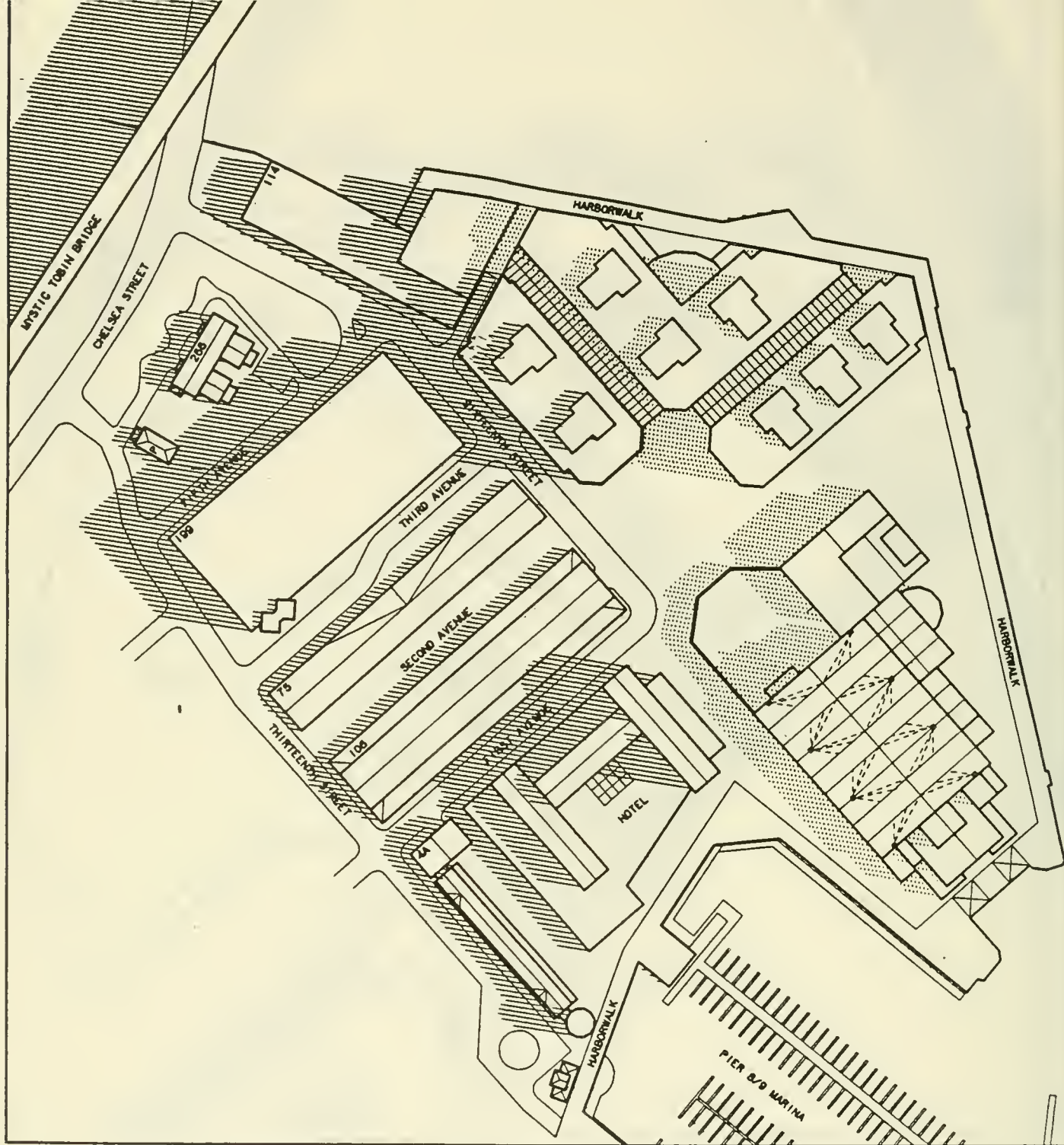


FIGURE: 8

PROPOSED CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center – Buildings B & C and New England Aquarium

JUNE 21, 9:00 AM
 BEARING: 99
 ALTITUDE: 40



200 0 200
 IN FEET
 100



BASE CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL B & C,
 NEW ENGLAND AQUARIUM)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

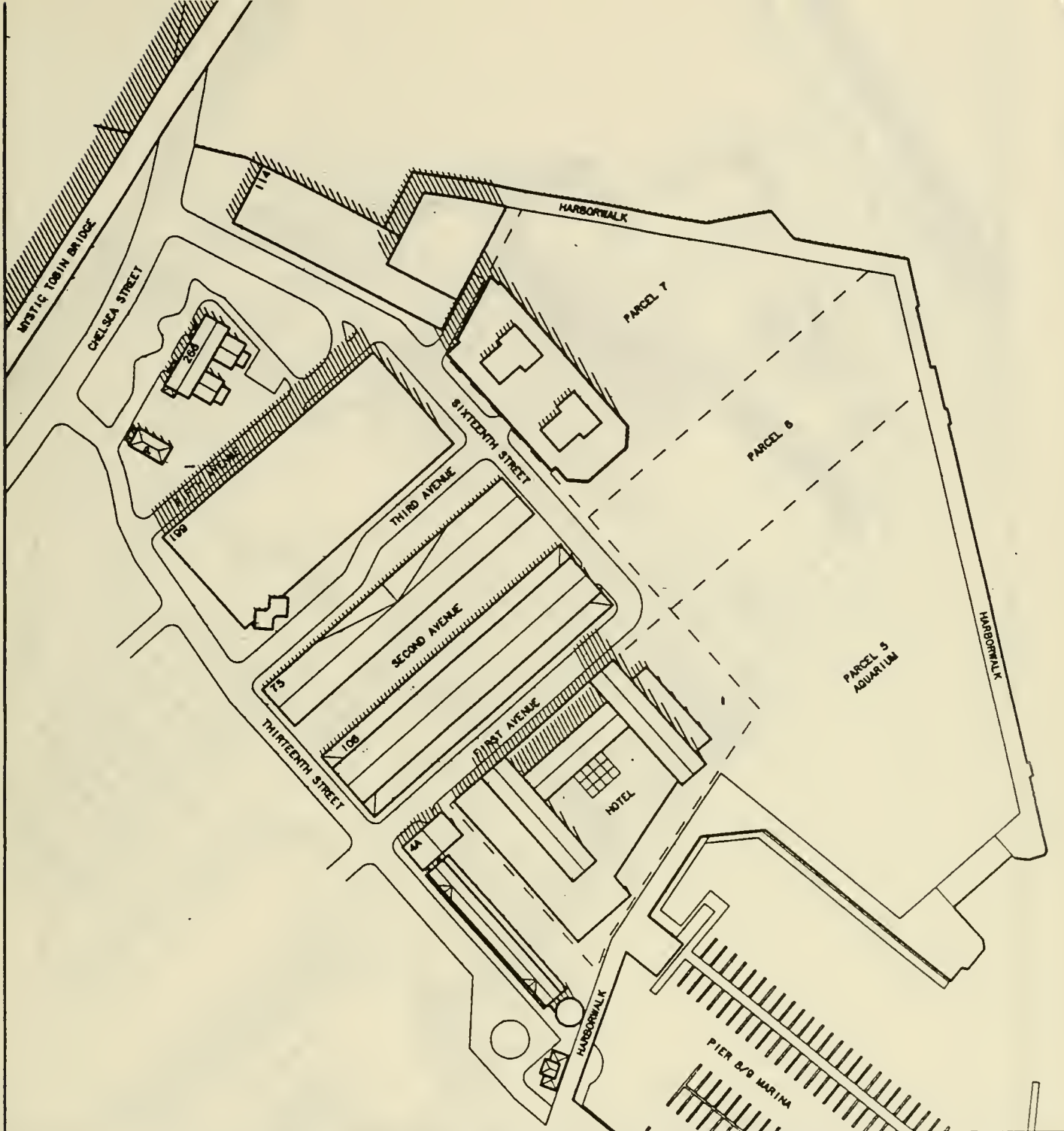


FIGURE: 9

BASE CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center – Buildings B & C and New England Aquarium

JUNE 21, 12:00 PM
 BEARING: 152
 ALTITUDE: 69



BASE CONDITION
 SHADOWS

200 0 200
 IN FEET

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

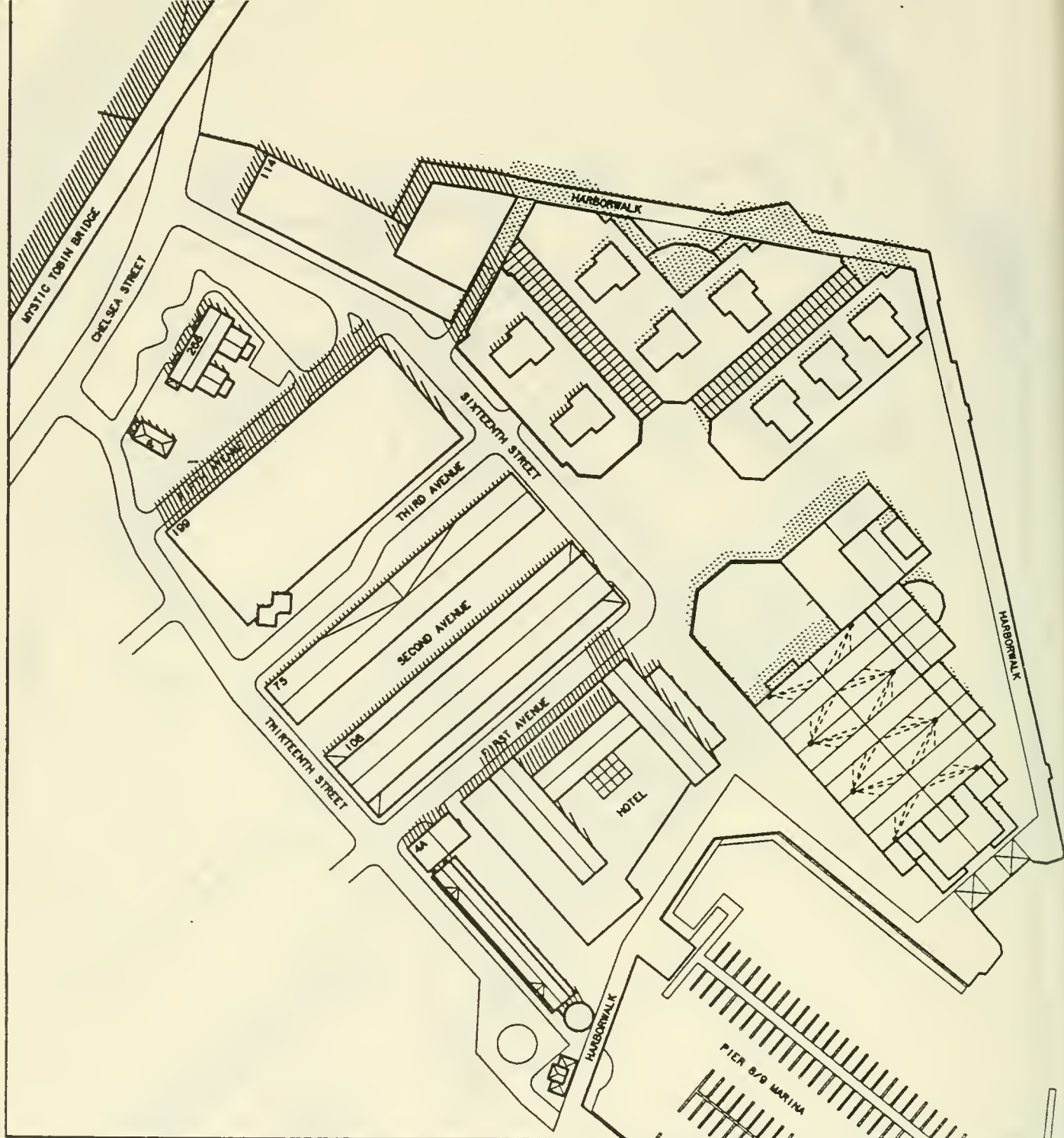


FIGURE: 10 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center – Buildings B & C
 and New England Aquarium

JUNE 21, 12:00 PM
 BEARING: 152
 ALTITUDE: 69



BASE CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL B & C,
 NEW ENGLAND AQUARIUM)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

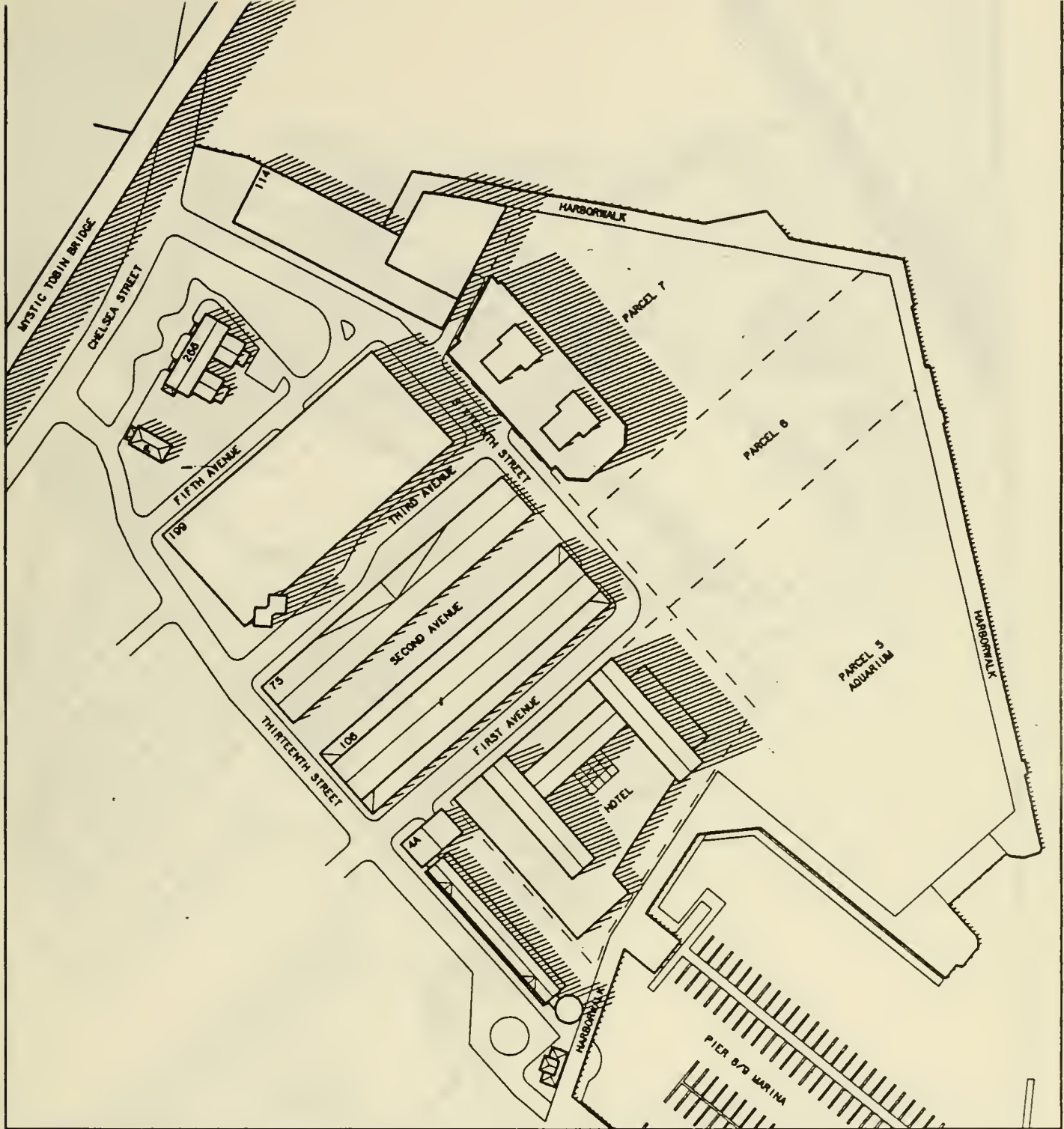


FIGURE: 11

BASE CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center – Buildings B & C
 and New England Aquarium

JUNE 21, 3:00 PM
 BEARING: 248
 ALTITUDE: 56



BASE CONDITION
 SHADOWS

200 0 200
 IN FEET

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

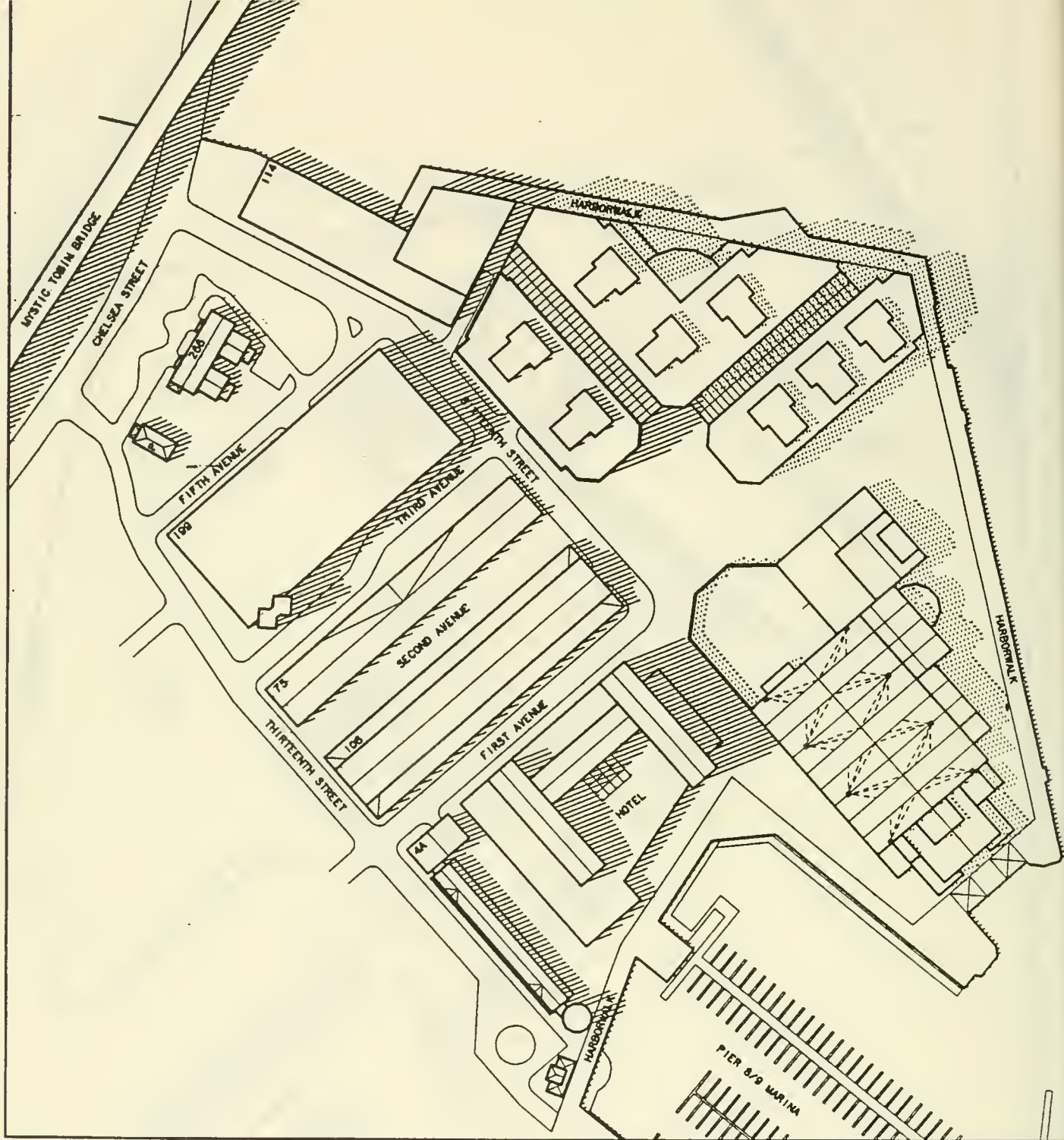


FIGURE: 12 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard^{*}
 Biomedical Research Center – Buildings B & C
 and New England Aquarium

JUNE 21, 3:00 PM
 BEARING: 248
 ALTITUDE: 56



200 0 200
 IN FEET



BASE CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL B & C,
 NEW ENGLAND AQUARIUM)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

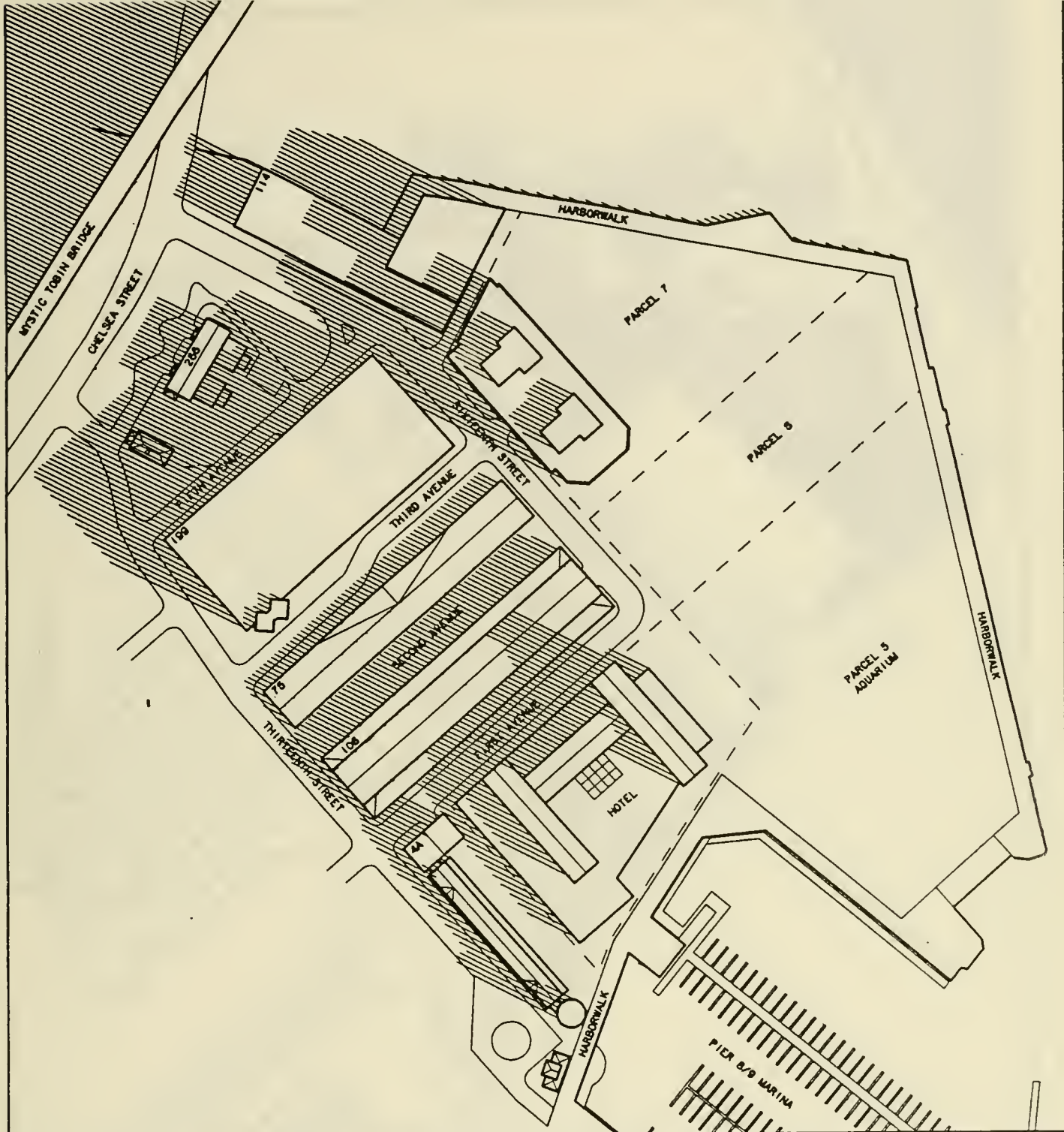


FIGURE: 13

BASE CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center – Buildings B & C and New England Aquarium

SEPTEMBER 21, 9:00 AM
 BEARING: 117
 ALTITUDE: 27



200 0 200
 100 IN FEET



BASE CONDITION
 SHADOWS

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

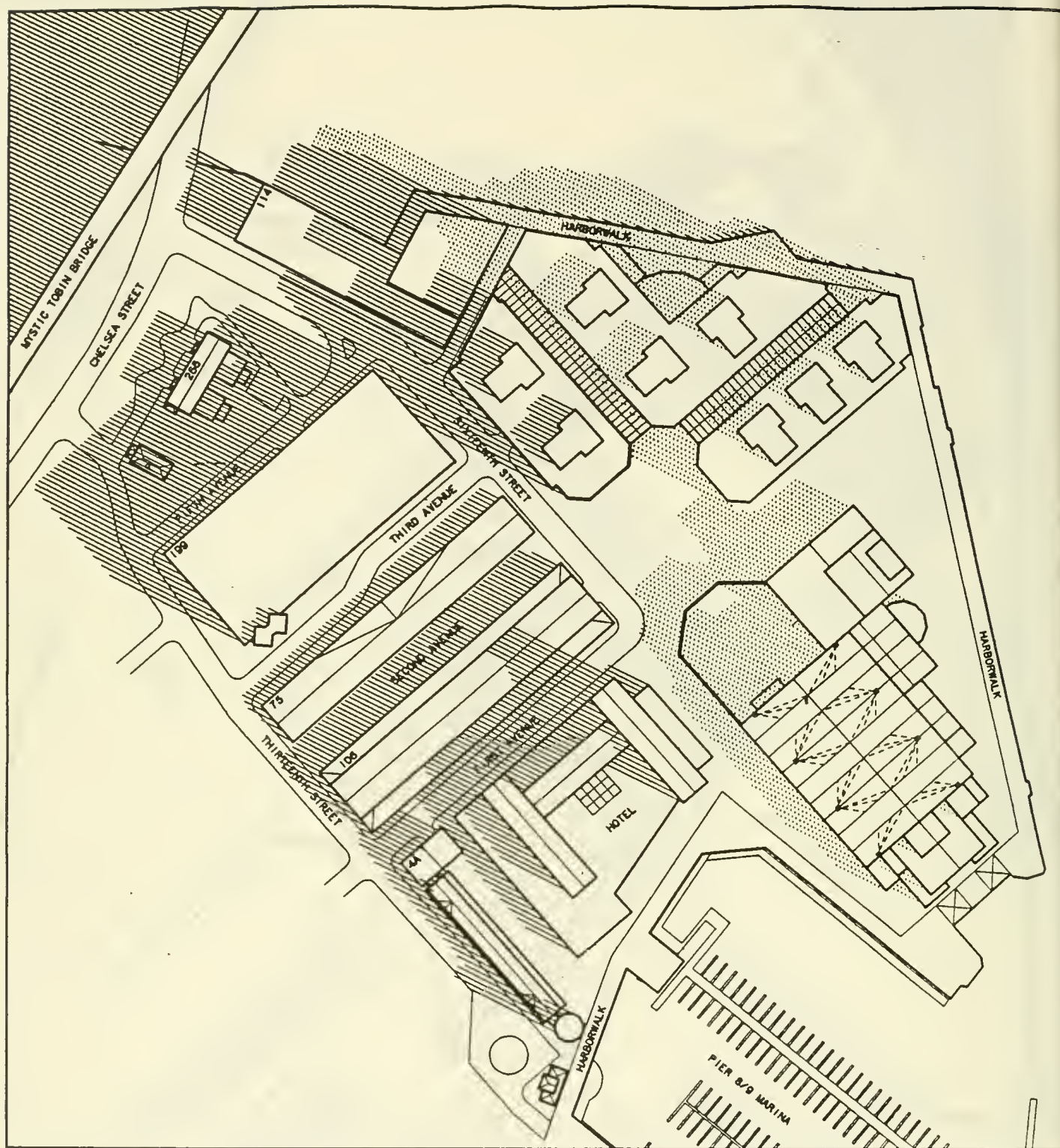


FIGURE: 14 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center – Buildings B & C
 and New England Aquarium

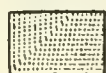
SEPTEMBER 21, 9:00 AM
 BEARING: 117
 ALTITUDE: 27



200 0 200
 100 IN FEET



BASE CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL B & C,
 NEW ENGLAND AQUARIUM)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

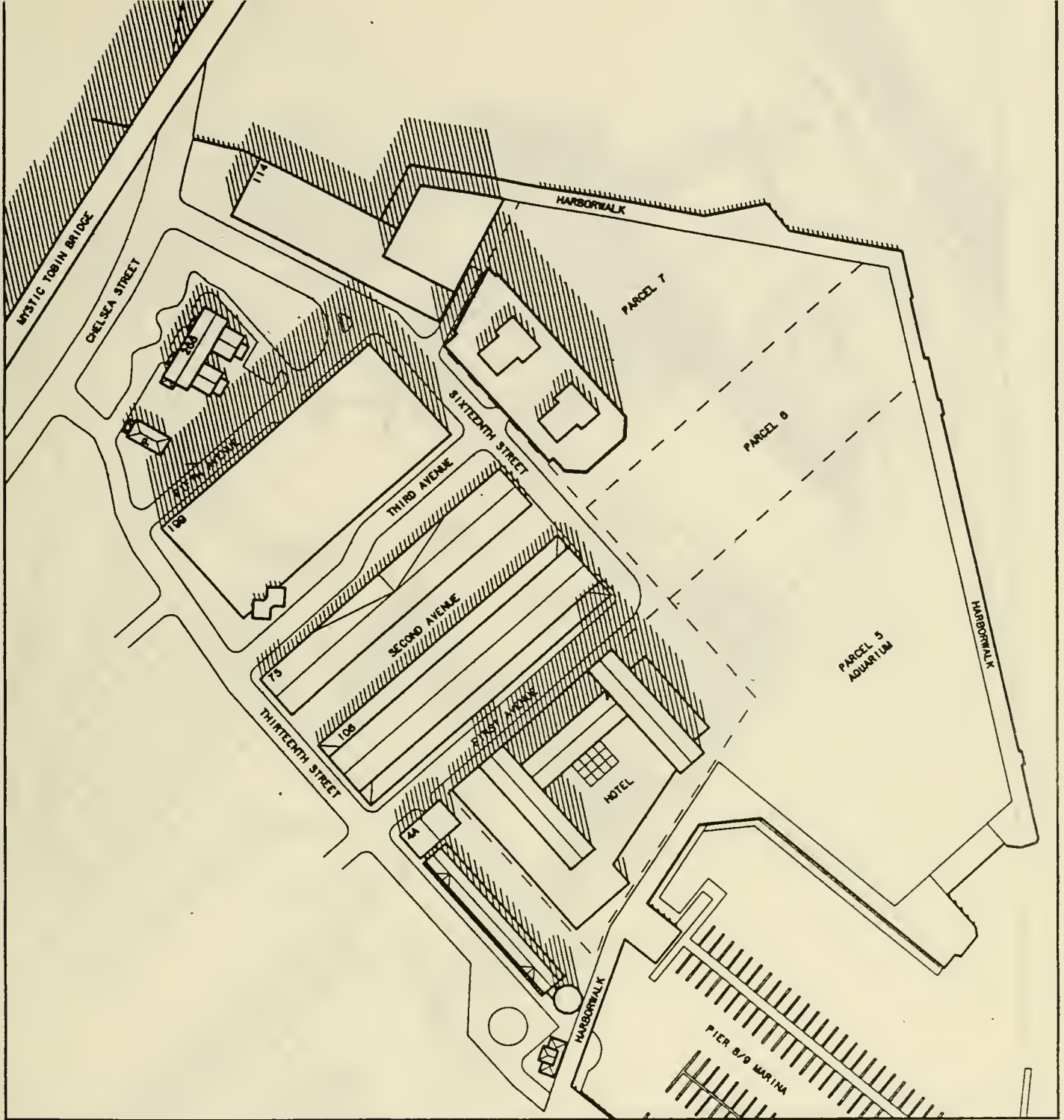


FIGURE: 15 **BASE CONDITIONS SHADOW ANALYSIS**
 Charlestown Navy Yard
 Biomedical Research Center – Buildings B & C
 and New England Aquarium

SEPTEMBER 21, 12:00 PM
 BEARING: 168
 ALTITUDE: 47



BASE CONDITION
 SHADOWS

200 0 200
 IN FEET
 100

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

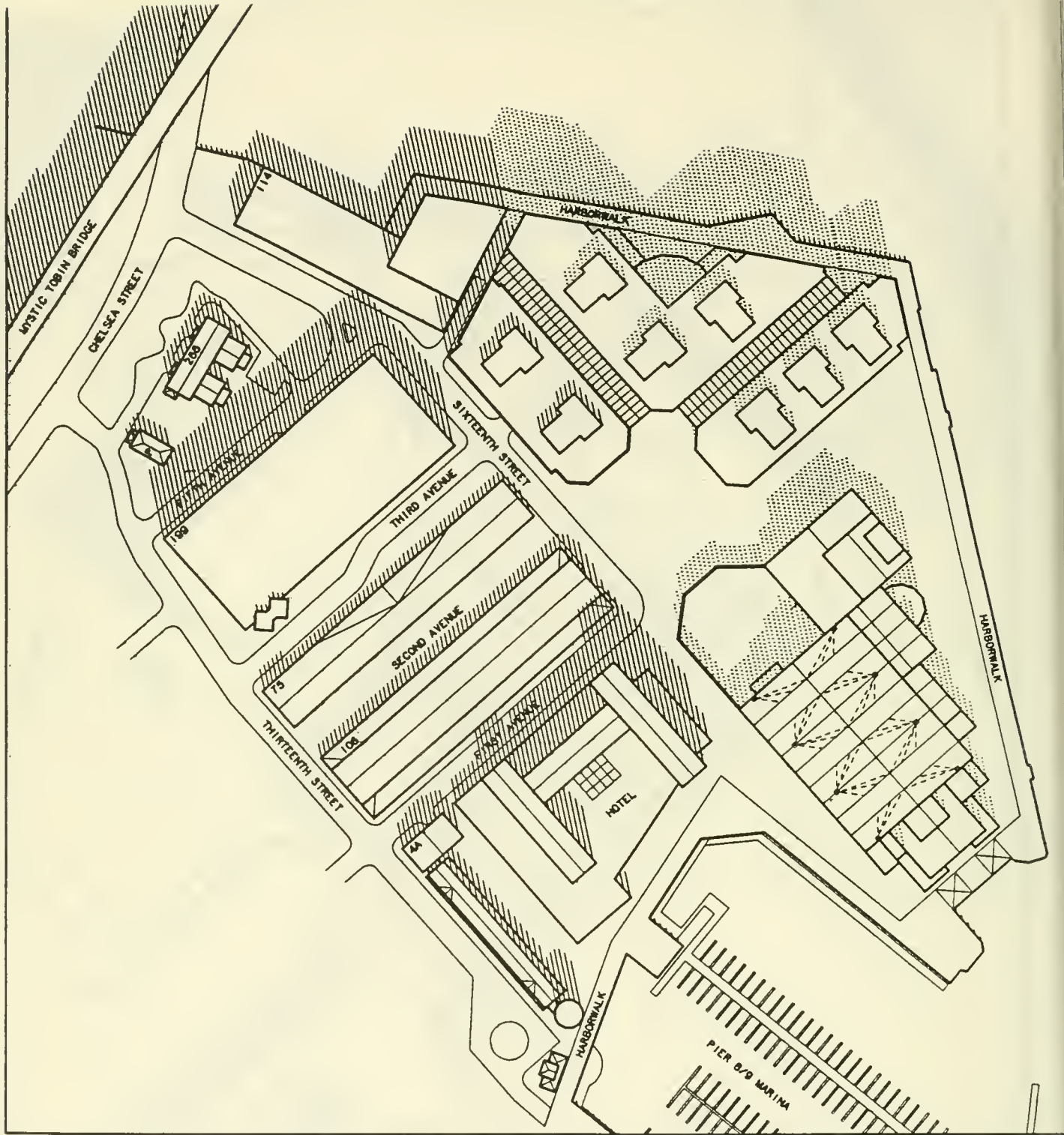


FIGURE: 16

PROPOSED CONDITIONS SHADOW ANALYSIS

Charlestown Navy Yard

Biomedical Research Center – Buildings B & C
and New England Aquarium

SEPTEMBER 21, 12:00 PM
BEARING: 168
ALTITUDE: 47



200 0 200
IN FEET



BASE CONDITION
SHADOWS



NET NEW SHADOWS
(BIOMEDICAL B & C,
NEW ENGLAND AQUARIUM)

PREPARED BY:
SASAKI ASSOCIATES, INC.
64 PLEASANT ST.
WATERTOWN, MA. 02172
30 AUGUST 1991

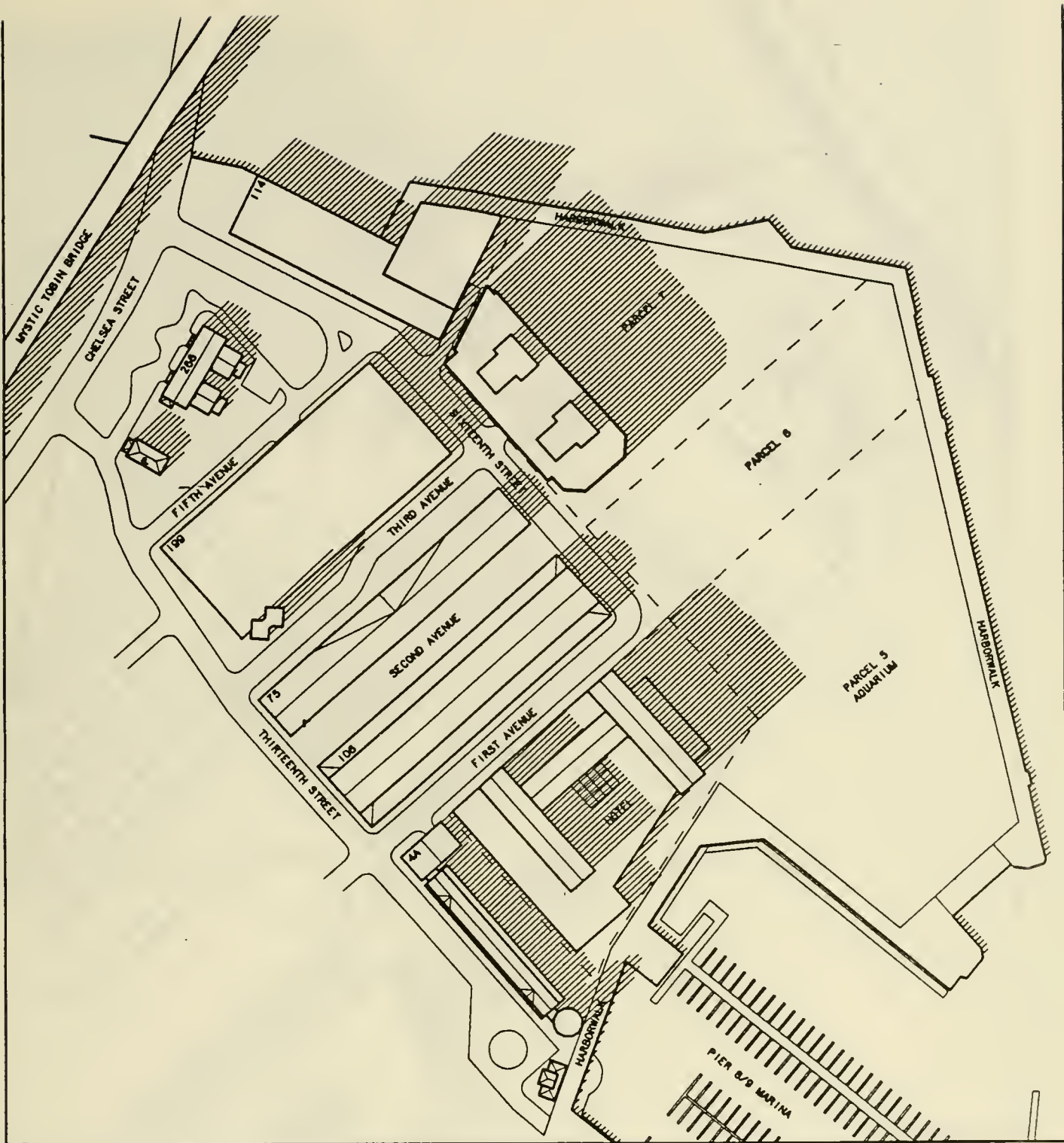


FIGURE: 17

BASE CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Buildings B & C and New England Aquarium

SEPTEMBER 21, 3:00 PM
 BEARING: 227
 ALTITUDE: 37



BASE CONDITION
 SHADOWS

200 0 100 200
 1 IN FEET

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

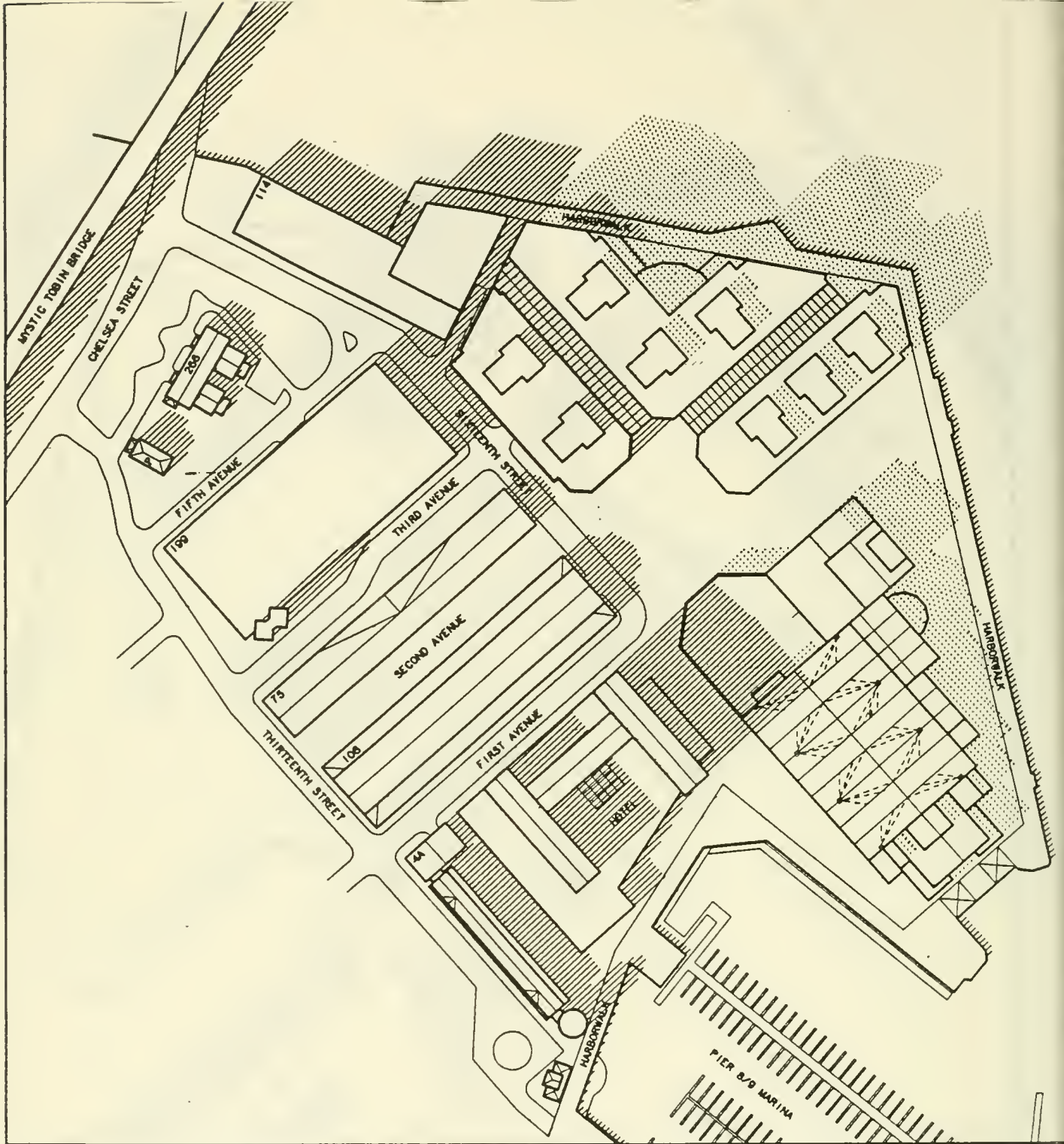


FIGURE: 18 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center – Buildings B & C
 and New England Aquarium

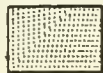
SEPTEMBER 21, 3:00 PM
 BEARING: 227
 ALTITUDE: 37



200 0 200
 100 IN FEET



BASE CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL B & C,
 NEW ENGLAND AQUARIUM)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

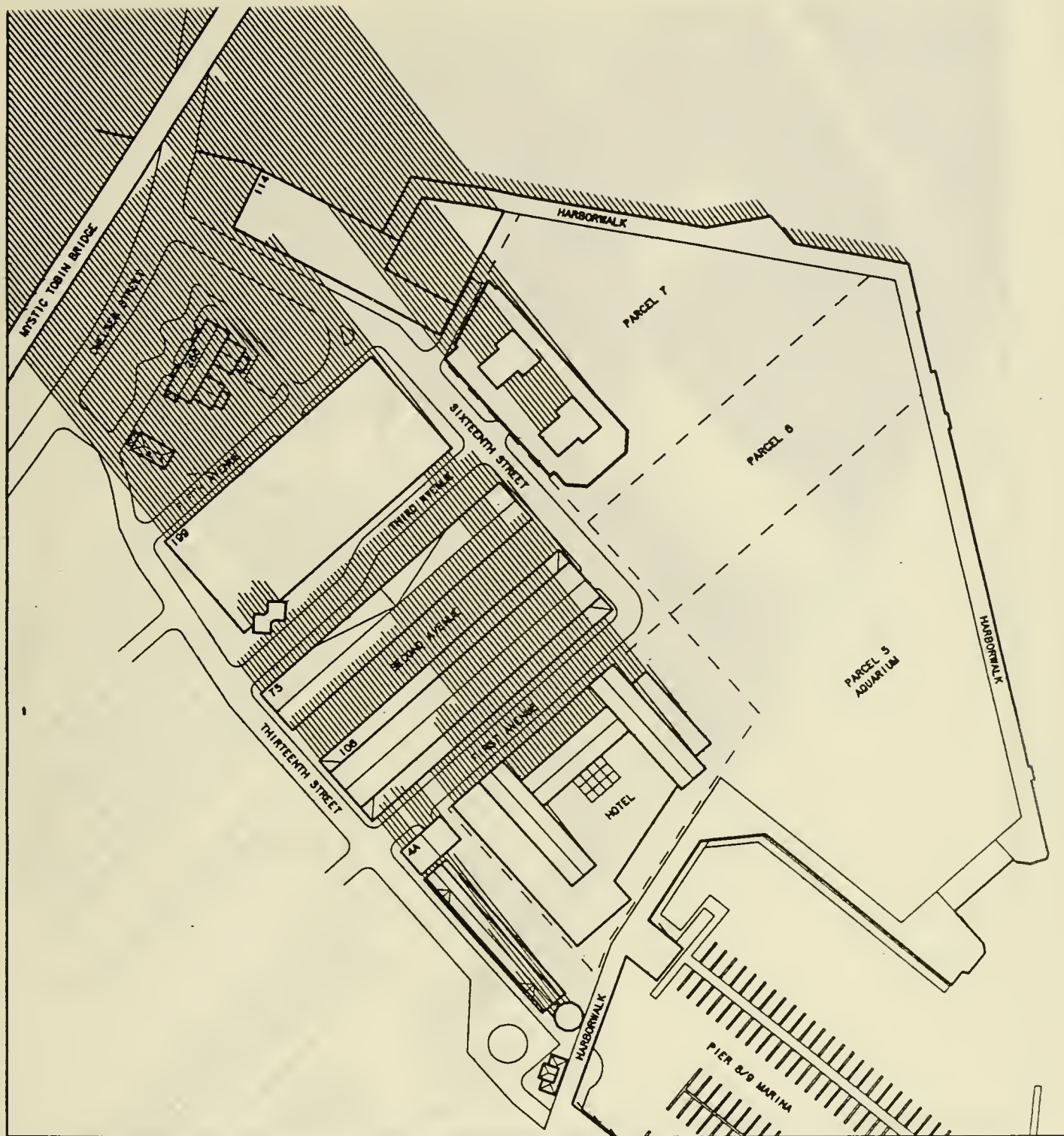


FIGURE: 19

BASE CONDITION SHADOW ANALYSIS

Charlestown Navy Yard

Biomedical Research Center - Buildings B & C

and New England Aquarium

DECEMBER 21, 9:00 AM
 BEARING: 142
 ALTITUDE: 15



BASE CONDITION
 SHADOWS

200 0 200
 IN FEET
 100

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

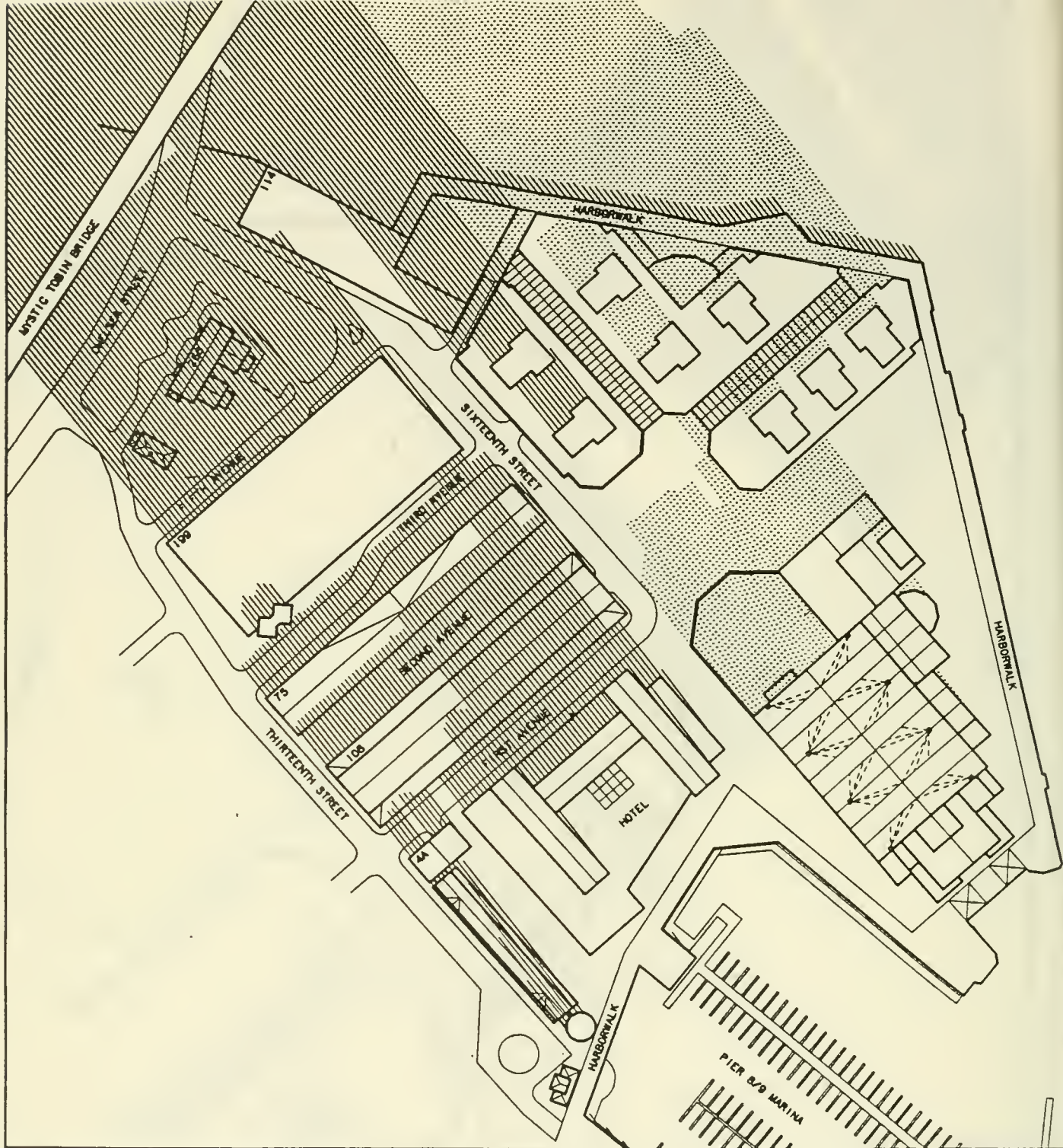


FIGURE: 20 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center – Buildings B & C
 and New England Aquarium

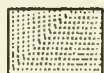
DECEMBER 21, 9:00 AM
 BEARING: 142
 ALTITUDE: 15



200 0 IN FEET
 100 200



BASE CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL B & C,
 NEW ENGLAND AQUARIUM)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

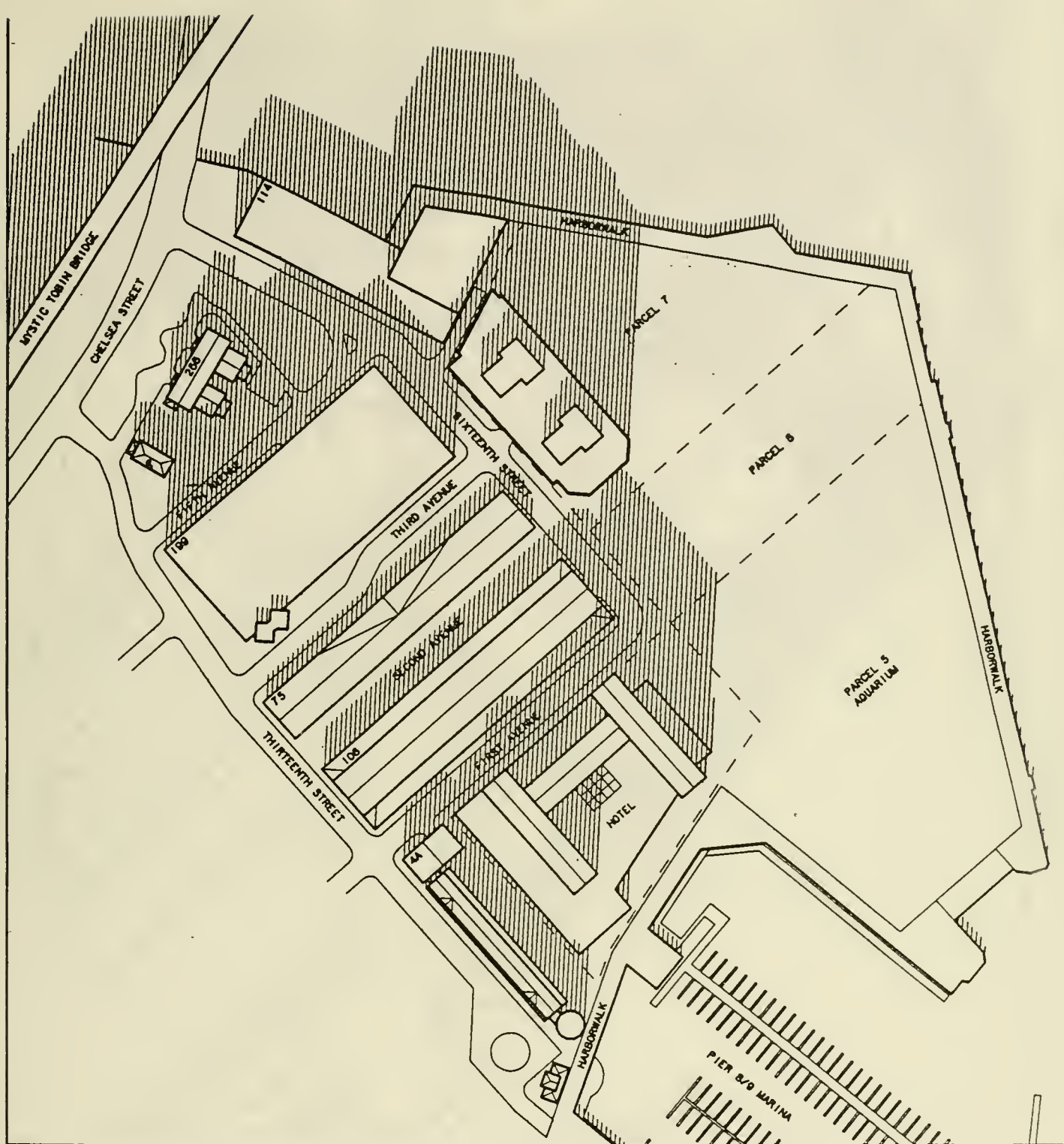


FIGURE: 21

BASE CONDITIONS SHADOW ANALYSIS

Charlestown Navy Yard

Biomedical Research Center - Buildings B & C

and New England Aquarium

DECEMBER 21, 12:00 PM
BEARING: 183
ALTITUDE: 25



200 0 200
IN FEET
100



BASE CONDITION
SHADOWS

PREPARED BY:
SASAKI ASSOCIATES, INC.
64 PLEASANT ST.
WATERTOWN, MA. 02172
30 AUGUST 1991

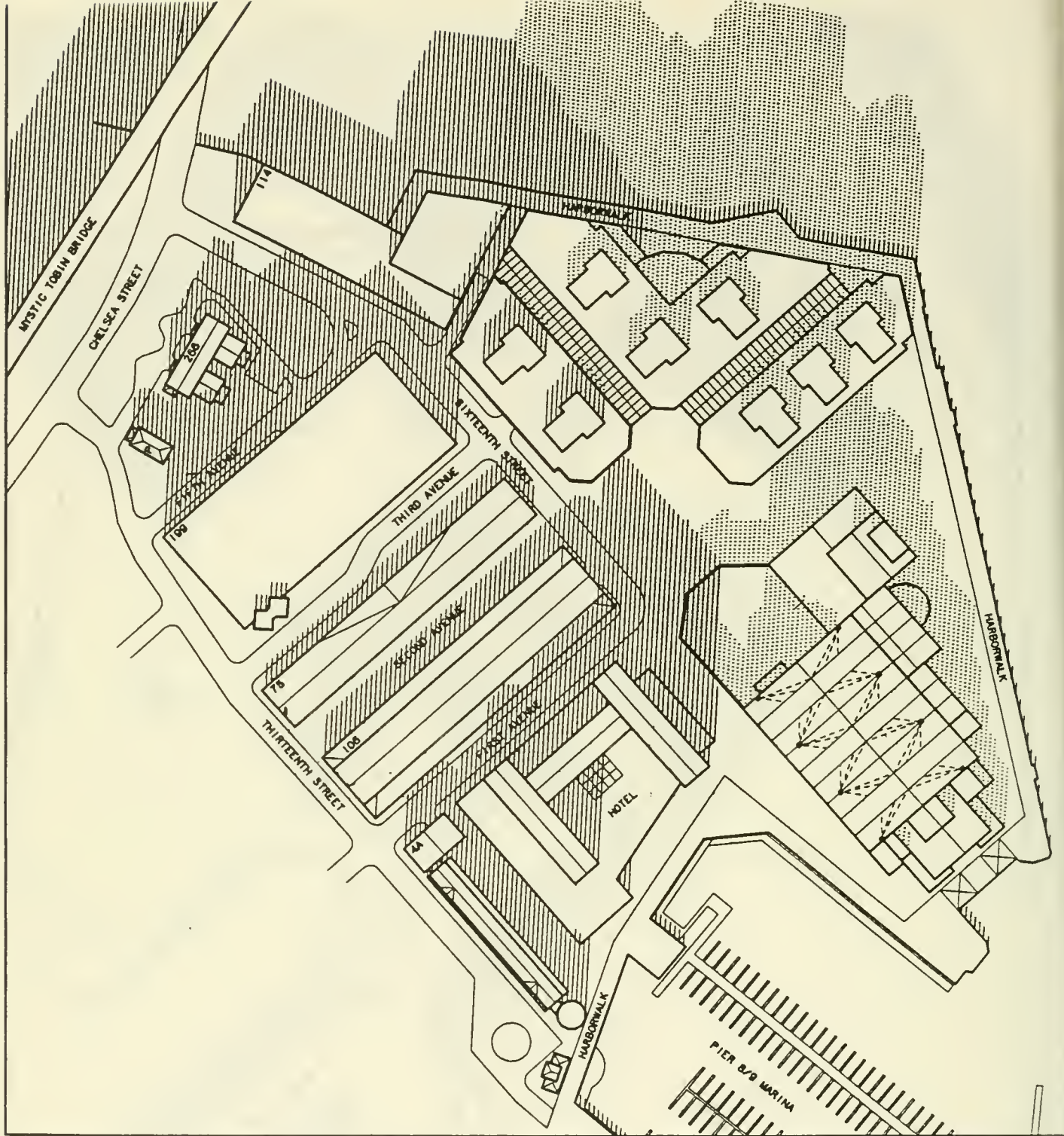


FIGURE: 22 PROPOSED CONDITIONS SHADOW ANALYSIS
 Charlestown Navy Yard
 Biomedical Research Center - Buildings B & C
 and New England Aquarium

DECEMBER 21, 12:00 PM
 BEARING: 183
 ALTITUDE: 25



200 0 200
 100 IN FEET



BASE CONDITION
 SHADOWS



NET NEW SHADOWS
 (BIOMEDICAL B & C,
 NEW ENGLAND AQUARIUM)

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

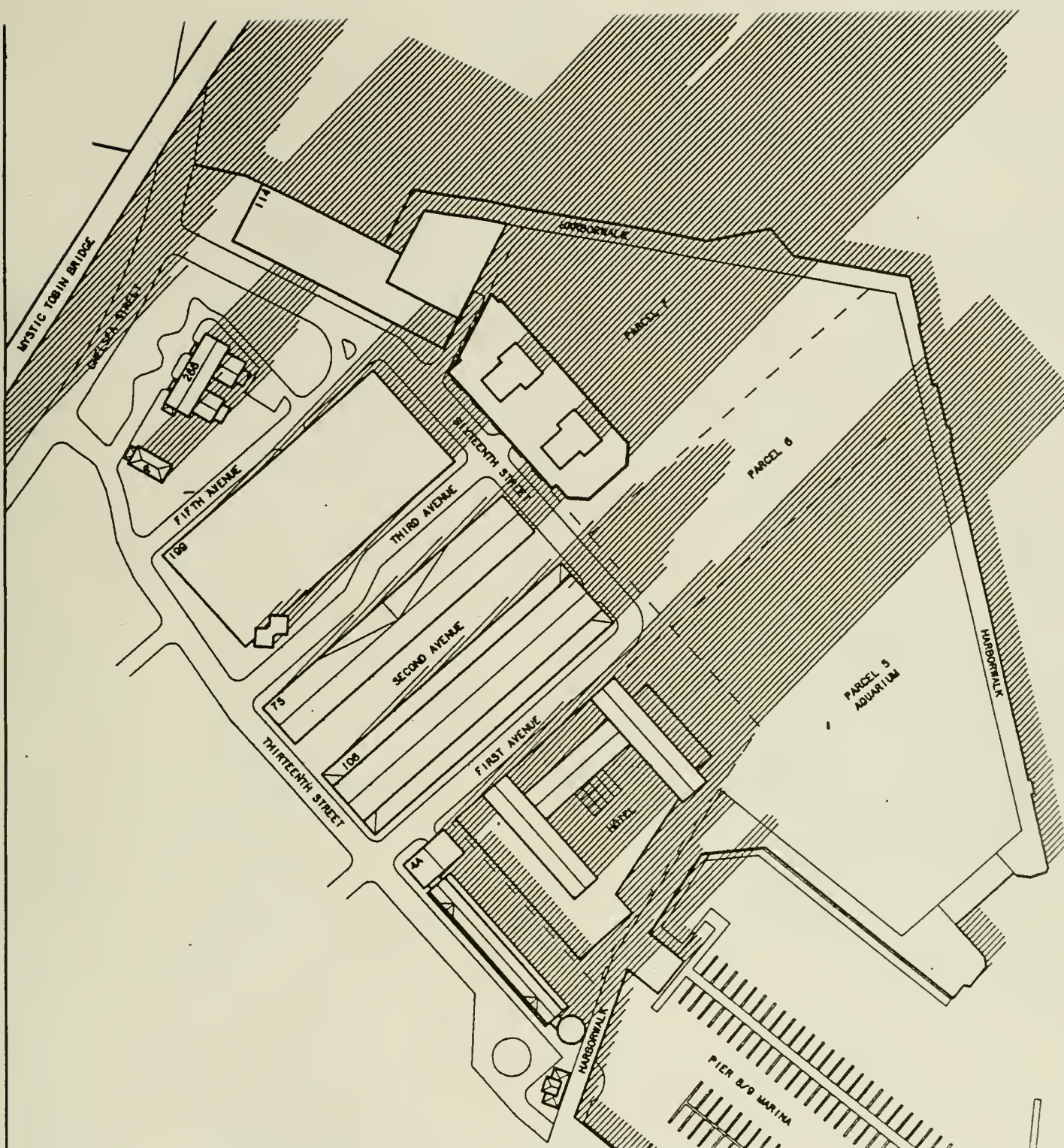


FIGURE: 23

BASE CONDITIONS SHADOW ANALYSIS Charlestown Navy Yard Biomedical Research Center - Buildings B & C and New England Aquarium

DECEMBER 21, 3:00 PM
 BEARING: 224
 ALTITUDE: 11



BASE CONDITION
 SHADOWS

200 0 100 200
 1 IN FEET

PREPARED BY:
 SASAKI ASSOCIATES, INC.
 64 PLEASANT ST.
 WATERTOWN, MA. 02172
 30 AUGUST 1991

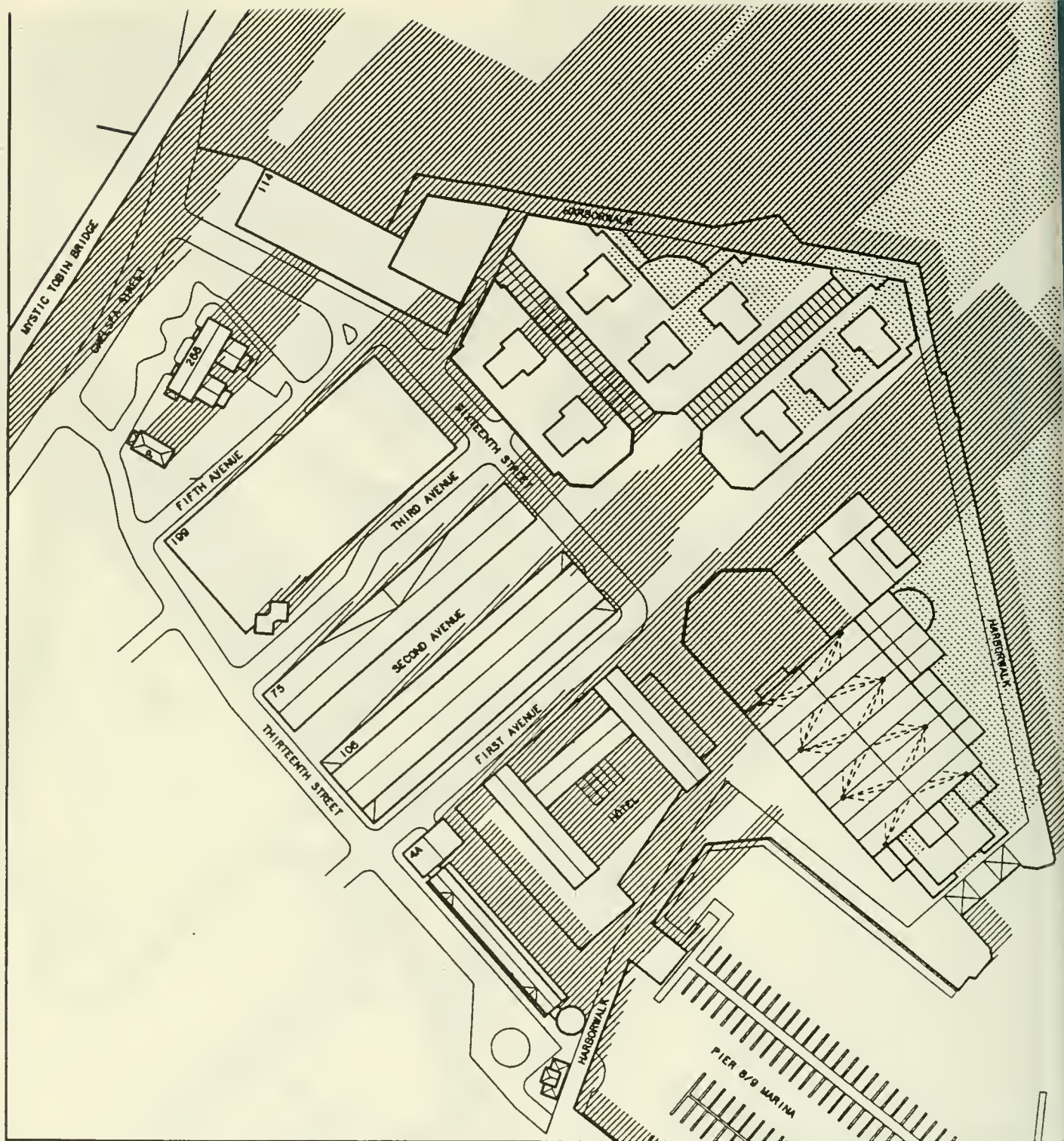


FIGURE: 24

PROPOSED CONDITIONS SHADOW ANALYSIS

Charlestown Navy Yard

Biomedical Research Center – Buildings B & C
and New England Aquarium

DECEMBER 21, 3:00 PM
BEARING: 224
ALTITUDE: 11



200 0 200
IN FEET



BASE CONDITION
SHADOWS



NET NEW SHADOWS
(BIOMEDICAL B & C,
NEW ENGLAND AQUARIUM)

PREPARED BY:
SASAKI ASSOCIATES, INC.
64 PLEASANT ST.
WATERTOWN, MA. 02172
30 AUGUST 1991

APPENDIX H
LETTERS OF SUPPORT

**CHARLESTOWN NAVY YARD REDEVELOPMENT DSEIR
LETTERS OF SUPPORT**

THE DOWNTOWN NORTH ASSOCIATION
FLOORCOVERS LOCAL UNION 2168
PLUMBERS LOCAL 12 BOSTON
PAINTERS AND ALLIED TRADES DISTRICT COUNCIL NO. 35
MASSACHUSETTS PILE DRIVERS LOCAL 56
RAPID FURNITURE REAL ESTATE
BRICKLAYERS AND ALLIED CRAFTSMEN LOCAL NO. 3, CHARLESTOWN
BRICKLAYERS AND LABORERS NON-PROFIT HOUSING COMPANY, BOSTON
GLASIERS ARCHITECTURAL METAL AND GLASSWORKERS LOCAL NO. 1044
BUILDING AND CONSTRUCTION TRADES COUNCIL OF THE METROPOLITAN
DISTRICT
BOSTON COUNCIL OF CARPENTERS, AFL-CIO
BOILERMAKERS LOCAL 29
MILLWRIGHT AND MACHINERY ERECTORS LOCAL 1121
IBEW LOCAL 103
NAVY YARD PLAZA DEVELOPMENT
INTERNATIONAL ASSOCIATION OF BRIDGE, STRUCTURAL AND ORNAMENTAL
IRON WORKERS LOCAL 7
T. CATALYST, INC. CHARLESTOWN
THE RAYMOND GROUP, CHARLESTOWN
GREATER BOSTON CHAMBER OF COMMERCE
KEEN DEVELOPMENT CORPORATION
NAGE HOUSING, INCORPORATED
J.W. FRENCH ASSOCIATES, INC. - LINDA NESHAMKIN, A.I.A.
J.W. FRENCH ASSOCIATES, INC. - JOHN W. FRENCH, A.I.A.
BLOSSOMS CAFE - CHARLESTOWN NAVY YARD - DYANE SILINS
THE HARBORWATCH RESTURANT - CHARLESTOWN NAVY YARD - ALAN
KINCADE
ANTHONY COSTA, 60 COLLEGE AVE. ARLINGTON, MA.
LIFE FOCUS CENTER, ONE CITY SQ. - JACK MILLERICK
LIBERTY BELL WHOLESALE GROCERY CO. 400 RUTHERFORD AVENUE
ROBERT BORZAKIAN, CHARLESTOWN
ELITE REALTY, CENTURY 21 31 CAMBRIDGE STREET, CHARLESTOWN
C&C FOOD SERVICE P.O. BOX 91. CHARLESTOWN
ELITE PROFESSIONAL SERVICES, CHARLESTOWN - JOSEPH MCGONAGLE
CONROY DEVELOPMENT CORPORATION, ONE 13TH ST. CHARLESTOWN
MCDONALD - MCHUGH BUILDERS INC. 250 MAIN ST. CHARLESTOWN
TOWN SHADE COMPANY, ONE THOMPSON SQUARE, CHARLESTOWN
TUDOR WHARF DEVELOPMENT CORP. JOHN ALLEN
CHARLESTOWN COMMUNITY SCHOOLS, 255 MEDFORD ST. CHARLESTOWN
FORMACS CONSTRUCTION INC. CHARLESTOWN
MICHAEL OWENS, 76 OLD LANDING WAY, CHARLESTOWN
MICHELLE ANDREA, 19 OLD LANDING WAY, CHARLESTOWN
BRENDA SCULLY, CHARLESTOWN

MICHELE LEONARD-BURNS, 16 SACKVILLE ST. CHARLESTOWN
WILLIAM WEIR, CHARLESTOWN
PAUL ALLEN, 21 OLD LANDING WAY, CHARLESTOWN
FRANCIS NARDONE, 80 OLD LANDING WAY, CHARLESTOWN
DAVID LAITTRE, CHARLESTOWN
PATRICK KEIGNEY, CHARLESTOWN
CARL ALLEN, CHARLESTOWN
CAROL ANNE OWENS, CHARLESTOWN
FRANCIS NARDONE, CHARLESTOWN
MICHELLE ANDREA, CHARLESTOWN
LAURIE BARENDS, CHARLESTOWN
NINA DALLI, CHARLESTOWN
JEANNETTE GRISDALE, CHARLESTOWN
DONALD SULLIVAN, CHARLESTOWN
EDWARD JAVAISKI, CHARLESTOWN
KIMBERELY REED, CHARLESTOWN
JAMES DONOVAN, CHARLESTOWN
DONALD VESSENDER, CHARLESTOWN
KAREN JANE, CHARLESTOWN
JOHN GEARTY, CHARLESTOWN
DENISE MACDOUGALL, CHARLESTOWN
KATHLEEN BYRNE, CHARLESTOWN
PAULA JACKSON, CHARLESTOWN
CHRISTINE M. CHIAMPPIA, CHARLESTOWN
ELIZABETH SWEENEY, CHARLESTOWN
LAURIE BARERDE, 25 COREY STREET, CHARLESTOWN
NINA M. KALLI, CHARLESTOWN
SHARLENE STEARNS, 78 OLD LANDING WAY, CHARLESTOWN
JOANNE JANIHIAN, 19 OLD LANDING WAY, CHARLESTOWN
KIMBERELY STEARNS, 78 OLD LANDING WAY, CHARLESTOWN
MARY RIZZO, 103 13TH STREET, CHARLESTOWN
DONNA FLAMMINI, 35B OLD LANDING WAY, CHARLESTOWN
EDWARD COOLEY, 55 DUNSTABLE STREET, CHARLESTOWN
MARY HURLEY, 42 PARK STREET, CHARLESTOWN
MARGRET HORGAN, 23 UNION STREET, CHARLESTOWN
DAVID SAIITA, 14 OLD LANDING WAY, CHARLESTOWN
CONNIE SAIITA, 14 OLD LANDING WAY, CHARLESTOWN
BRENDA K. SCULLEY, 50 HARVARD STREET, CHARLESTOWN
CHARLES A. SAIITA, 14 OLD LANDING WAY, CHARLESTOWN
KATHRINE MACDONALD 9A OLD LANDING WAY, CHARLESTOWN
JOAN JONES, 15A OLD LANDING WAY, CHARLESTOWN
PATTY ROSHER, 46 OLD LANDING WAY, CHARLESTOWN
HELEN LEAHY, 104 ELM STREET, CHARLESTOWN
CATHERINE OWENS, CHARLESTOWN
MICHEAL SHEA, 24/26 CONCORD STREET, CHARLESTOWN
SHEILA MCLAUGHLIN, 8 SEMINARY STREET, CHARLESTOWN
MARY STEARNS, CHARLESTOWN
WILLIAM ALLEN, 85 OLD LANDING WAY, CHARLESTOWN

DONALD R. SULLIVAN, 18 TRENTON STREET, CHARLESTOWN
JEANETTE PRENDABLE, 31 COOK STREET, CHARLESTOWN
THOMAS ALLEN, 71 C OLD LANDING WAY, CHARLESTOWN
MAUREEN BURKE, 95B OLD IRONSIDES WAY, CHARLESTOWN
PATRICIA KEIGNEY, CHARLESTOWN
CONNIE TRACEY, 0 O'REILLY WAY, CHARLESTOWN
JUDITH CLOUGH, CHARLESTOWN
JUDITH A. KELLY, 15 D OLD IRONSIDES WAY, CHARLESTOWN
SHAWN MACDONALD, 50 OLD IRONSIDES WAY, CHARLESTOWN
MARY MALONEY, 1 HILARY STREET, CHARLESTOWN
BERNARD AUCH, 10 CARNEY CT., CHARLESTOWN
PAUL MAHONEY, 42 MT. VERNON STREET, CHARLESTOWN
JOHN GREATORIX, 113 BUNKER HILL STREET, CHARLESTOWN
MARY FISHER, 17 COREY STREET, CHARLESTOWN
KIM DAVIS, 105 BUNKER HILL STREET, CHARLESTOWN
LINDA EVENS, CHARLESTOWN
ELVIRA NELSON, CHARLESTOWN
MICHAEL CONLEY, 92 MONUMENT STREET, CHARLESTOWN
ELIZABETH SWEENEY, CHARLESTOWN
AGNES L. CONLEY, CHARLESTOWN
ANDREA GOLDBERG, CHARLESTOWN
NANCY KING, CHARLESTOWN
KAREN M. LANE, CHARLESTOWN
DENISE MACDONALD, 19B OLD IRONSIDES WAY, CHARLESTOWN
KATHLEEN BYRNE, 13 COOK STREET, CHARLESTOWN
SUSAN FERRY 105 BUNKER HILL STREET, CHARLESTOWN
EDWARD GODAKOWSKI, 28 GREEN STREET, CHARLESTOWN
ANN SAITTA, CHARLESTOWN
KIM GORMAN, 11 ELWOOD STREET, CHARLESTOWN
MARY CEROLIA, 70 OLD LANDING WAY, CHARLESTOWN
DONALD HENNESSY, 302 BUNKER HILL STREET, CHARLESTOWN
LINDA DONOVAN, 47B OLD IRONSIDES WAY, CHARLESTOWN
MARY HOWELL, 51 BELMONT STREET, CHARLESTOWN
THERESA C. RING, 55A OLD LANDING WAY, CHARLESTOWN
DANIEL RING 276 BUNKER HILL STREET, CHARLESTOWN
JAMES DONOVAN 47B OLD IRONSIDES WAY, CHARLESTOWN
MARY M. CHIAPPA, 302 BUNKER HILL STREET, CHARLESTOWN
BARBARA PHILLIPS, 25 WALFORD WAY, CHARLESTOWN,
MICHAEL DAVIDE, 26 A DUNSTABLE STREET, CHARLESTOWN
MATTHEW J. LOMBARD, 444 MAIN STREET, CHARLESTOWN
AILLEEN C. SMITH 22 HARVARD STREET, CHARLESTOWN
PAUL J. TWOMEY, 116 BARTLETT ST. CHARLESTOWN
MARIE SMITH, 33 POLK ST. CHARLESTOWN
KATHLEEN PERITO, 42 TUFTS ST. CHARLESTOWN
CHRISTOPHER PERITO, 42 TUFTS ST. CHARLESTOWN
MICHAEL D'AMBROSSIO, 37 WASHINGTON ST. CHARLESTOWN
MARY MCNELLEY, 16 UNION ST. CHARLESTOWN
STEPHEN THOPMSON, 37 WASHINGTON ST. CHARLESTOWN

ROBERT THOMPSON 37 WASHINGTON ST. CHARLESTOWN
KATHERINE THOMPSON 37 WASHINGTON ST, CHARLESTOWN
PATRICIA WALSH, 48 WASHINGTON ST. CHARLESTOWN
TIMOTHY WALSH, 48 WASHINGTON ST. CHARLESTOWN
KIMBERELY WALSH, 48 WASHINGTON ST. CHARLESTOWN
DENNIS SULLIVAN, 74 WASHINGTON ST. CHARLESTOWN
CATHERINE SULLIVAN, 26 UNION ST. CHARLESTOWN
RICHARD J. SCANLON, 62 UNION ST. CHARLESTOWN
DAVID GLYNN, 42 UNION ST. CHARLESTOWN
ROBERT MARLOE, 48 WASHINGTON ST. CHARLESTOWN
JAMES MULDOON, 24 CALDWELL ST, CHARLESTOWN
KALIE PARKS, 17 PARKER ST. CHARLESTOWN
JOANNE ENOS, 90 GREEN ST. CHARLESTOWN
JOHN ENOS, 90 GREEN ST. CHARLESTOWN
JOAN ENOS, 90 GREEN STREET, CHARLESTOWN
RICHARD BURKE, 16 LAWRENCE ST. CHARLESTOWN
CELIA POWERS, 48 ALLSTON ST. CHARLESTOWN
JACQUELINE SPRAQUE, 26 SOLEY ST. CHARLESTOWN
MICHAEL CHARBONNIER, 51 BALDWIN ST, CHARLESTOWN
ROBERT POWERS, 48 ALLSTON ST. CHARLESTOWN
JOSEPH MAHONEY, 366 MAIN ST. CHARLESTOWN
RITA MAHONEY, 366 MAIN ST. CHARLESTOWN
MATTHEW MAHONEY, 366 MAIN ST. CHARLESTOWN
MARK GORMAN, 11 ELLWOOD ST. CHARLESTOWN
DENESE POWERS, 48 ALLSTON ST. CHARLESTOWN
CLAIRE P. LYNCH, 25 TIBBETSTOWN, WAY, CHARLESTOWN
CHERYL LYNCH, 25 TIBBETSTOWN WAY, CHARLESTOWN
MICHELE LYNCH, 25 TIBBETSTOWN WAY, CHARLESTOWN
SHARON LYNCH, 25 TIBBETSTOWN WAY, CHARLESTOWN
KELLY DOHERTY, 3 GRANTS CT. CHARLESTOWN
JOHN HURLEY 103 NINTH ST. CHARLESTOWN
FRANCIS WHITLOCK, 16 PARKER ST. CHARLESTOWN
KEVIN KELLY 4 PLEASANT STREET, CHARLESTOWN
MICHAEL BUTLER, 10 MT. VERNON ST. CHARLESTOWN
MICHAEL ANTHONY, 19 MONUMENT AVE, CHARLESTOWN
PATRICIA POWERS, 13 SHORT ST. CHARLESTOWN
JOHN WHITLOCK, 16 PARKER ST. CHARLESTOWN
PATRICIA WHITLOCK, 16 PARKER ST. CHARLESTOWN
JAMES WHITLOCK, 16 PARKER ST. CHARLESTOWN
PAULA KIRK, 9 ADAMS ST. CHARLESTOWN
NANCY CROSBY, 79 BARTLETT ST. CHARLESTOWN
JOSEPH WHITLOCK, 16 PARKER ST. CHARLESTOWN
ARTHUR RUSSELL, 68 MEDFORD ST. CHARLESTOWN
THOMAS CROSBY, 79 BARTLETT ST. CHARLESTOWN
MARY SULLIVAN, 17 TENTON ST. CHARLESTOWN
PATRICIA CALLAHAN, 17 TRENTON ST. CHARLESTOWN
MICHAEL GAUTREAU 12 PEARL ST. CHARLESTOWN
EDWARD GAUTREAU, 12 PEARL ST. CHARLESTOWN

DANIEL MATTHEWS, 31 MYSTIC ST. CHARLESTOWN
HELEN GEEZIL, 130 WALFORD WAY, CHARLESTOWN
ANN DOHERTY, 3 GRANTS CT. CHARLESTOWN
PHILIP DOHERTY, 3 GRANTS CT. CHARLESTOWN
KAREN DOHERTY, 3 GRANTS CT. CHARLESTOWN
ALBERT TITCOMB, 58 DECATUR ST. CHARLESTOWN
TERRY TITCOMB, 58 DECATUR ST. CHGARLESTOWN
PHILIP DOHERTY JR. 3 GRANTS CT. CHARLESTOWN
SCOTT GEEZIL, 17 PARKER ST. CHARLESTOWN
JOHN GEEZIL, 412 CARNEY CT. CHARLESTOWN
MARY CALLAHAN, 35 BALDWIN ST. CHARLESTOWN
RITA GAUTREAU, 12 PEARL ST. CHARLESTOWN
EDWARD CALLAHAN, 17 TRENTON ST. CHARLESTOWN
NANCY RUSSELL, OLD LANDING WAY CHARLESTOWN
WILLIAM KIRK, 9 ADAMS ST. CHARLESTOWN
KEITH LEAHY, 7 MARSHALL PLACE, CHARLESTOWN
DOUG MACDONALD, 31 OLD LANDING WAY, CHARLESTOWN
KEITH A. LEAHY SR. 105 RUTHERFORD AVE. CHARLESTOWN
ANTHONY HOLLIEN, 18 UNION ST. CHARLESTOWN
MICHAEL D'AMBROSSIO JR. 37 UNION ST. CHARLESTOWN
MICHAEL WALSH, 36 UNION ST. CHARLESTOWN
MARY O'LEARY, 20 LYNDENBORO ST. CHARLESTOWN
JOSEPH DOYLE, 250 MAIN ST. CHARLESTOWN
ELLEN MELAUGH, 63D OLD IRONSIDES WAY CHARLESTOWN
MRS. ELLEN MELAUGH, 63D OLD IRONSIDES WAY CHARLESTOWN
JOSEPH MCHUGH, 250 MAIN ST. CHARLESTOWN
WILLIAM SHEEHAN, 241 BUNKER HILL ST. CHARLESTOWN
LISA FERRY, 9 O'REILLY WAY, CHARLESTOWN
IRVING LEE, 33 COREY ST. CHARLESTOWN
DONALD WHALEN, 77 OLD LANDING WAY CHARLESTOWN
FELICIA R. KIRK, 37 BARTLETT ST. CHARLESTOWN
JIM COPPINGER, 71 TIBBETSTOWN WAY, CHARLESTOWN
HELEN J. PENEIO, 21 PHIPPS ST. CHARLESTOWN
BARBRA HOWE, 18 ALLSTON ST. CHARLESTOWN
MICHAEL J. BURTON, 33 OLD LANDING WAY CHARLESTOWN
GUY V. PERITO, 42 TUFTS ST. CHARLESTOWN
PATRICK WALSH 49 WASHINGTON ST. CHARLESTOWN
ALBERT SHEA 90 ELM ST. CHARLESTOWN
GEORGE L. MACDONALD, 9A OLD LANDING WAY CHARLESTOWN
PATRICIA SULLIVAN 29 UNION ST. CHARLESTOWN
MARY COCHRAN, 15C OLD IRONSIDES WAY CHARLESTOWN
MARY BALLER, 110 RUTHERFORD AVE. CHARLESTOWN
SUSAN BRISSETT, 27A TIBBETSTOWN WAY, CHARLESTOWN
ELLEN MCINTOSH, 87 RUSSELL ST, CHARLESTOWN
DOROTHY F. GREATORREX, 73 OLD LANDING WAY, CHARLESTOWN
DANIEL EVERS, 49 PEARL ST, CHARLESTOWN
DONNA AUCH, 10 CARNEY CT. CHARLESTOWN
THERESA BOUCHER, 114 OLD LANDING WAY, CHARLESTOWN

THOMAS F. GILLGUNN JR. 151 BUNKER HILL ST. CHARLESTOWN
JASON MACDONALD, 106 OLD IRONSIDES WAY, CHARLESTOWN
JACK LEEMAN, 103 9TH ST. CHARLESTOWN
MARK DILL, 387 BUNKER HILL ST. CHARLESTOWN
ROSE WALSH, 17 SALEM ST. CHARLESTOWN
MICHELLE PULEIO, 113A DUNSTABLE ST. CHARLESTOWN
ROBERT SCHAEFFER, 364 BUNKER HILL ST. CHARLESTOWN
ANN MARIE PULEIO, 113A DUNSTABLE ST. CHARLESTOWN
DEBORAH BURKE, 516 MEDFORD ST. CHARLESTOWN
JENNIFER BEASLEY, 104 BALDWIN ST. CHARLESTOWN
SEAN BUCKLEY, 332 A MAIN ST. CHARLESTOWN
PATRICK SULLIVAN 24 PEARL ST. CHARLESTOWN
JOSEPH KELLY, 35 GREEN ST. CHARLESTOWN
SARA MIZNER, 27 SHIPWAY PLACE, CHARLESTOWN
PAUL COLLINS, 31 GREEN ST. CHARLESTOWN
STEPHEN MACDONALD, 7 MARSHALL BLOCK CHARLESTOWN
KAREN KLASS, 276 BUNKER HILL ST. CHARLESTOWN
CHIP REILLY, 276 BUNKER HILL ST. CHARLESTOWN
THOMAS CARROLL, 34 TIBBETSTOWN WAY, CHARLESTOWN
MARGRET OWENS, 62 DECATUR ST. CHARLESTOWN
KATHLEEN GRIFFIN, 26 POLK ST. CHARLESTOWN
CHARLENE SHEAN, 10 TUFTS ST. CHARLESTOWN
JEANETTE NOONAN, 52 TUFTS ST. CHARLESTOWN
JACQUELINE BRENNAN, 25 AUSTIN ST. CHARLESTOWN
CYNTHIA L. BLAKIE, 25 SAMUEL MORSE WAY, CHARLESTOWN
KIMBERELY KELLY, 10 SALEM ST. AVE. CHARLESTOWN
DEIDRE MALLOY, 31 WINTHROP ST. CHARLESTOWN
ELIZABETH RUSSELL, 17 CARNEY CT. CHARLESTOWN
CAROL WALSH, 17 CARNEY CT. CHARLESTOWN
MARGRET GONZALES, 17 CARNEY CT. CHARLESTOWN
STACEY DOE, 17 CARNEY CT. CHARLESTOWN
HELEN ALLEN, 41 CARNEY CT. CHARLESTOWN
JOHN DOHERTY, 233 MAIN ST. CHARLESTOWN
ELLEN HARKINS, 89 TIBBETTSTOWN WAY, CHARLESTOWN
ELIZABETH TOBIN, 66 DECATOR ST. CHARLESTOWN
KERRI MARTIN, 50 MONUMENT ST. CHARLESTOWN
DAVID MARSDEN, 50 MONUMENT ST. CHARLESTOWN
STEPHEN CAMPBELL, 50 MONUMENT ST. CHARLESTOWN
FRANCES CAMPBELL, 50 MONUMENT ST. CHARLESTOWN
BARBARA MARTIN, 50 MONUMENT ST. CHARLESTOWN
MILDRED BROWN, 50 MONUMENT ST. CHARLESTOWN
CLAIR FOINACK, 50 MONUMENT ST. CHARLESTOWN
THOMAS PLATT, 50 MONUMENT ST. CHARLESTOWN
BARBARA GRIFFIN, 50 MONUMENT ST. CHARLESTOWN
VIRGINA M. TURNER 7 HARVARD ST. CHARLESTOWN
ELIZABETH PETERSON, 17 COREY ST. CHARLESTOWN
GAYLE WILKINS, 42 OLD LANDING WAY, CHARLESTOWN
LYNNE M. WOODS, 99C OLD IRONSIDES WAY, CHARLESTOWN

RICHARD TITCOMB, 105 RUTHERFORD WAY, CHARLESTOWN
LEO BOUCHER, 54 OLD IRONSIDES WAY, CHARLESTOWN
ELIZABETH HANSCOM, 580 O'BRIEN CT. CHARLESTOWN
SWAN HICKEY, 85 RUSSELL ST. CHARLESTOWN
SHAWN AWBREY, 45 MYSTIC ST. CHARLESTOWN
MARGRET CUMMINGS, 52 OLD LANDING WAY, CHARLESTOWN
MARY ELLEN RUSSELL, 31 TUFTS ST. CHARLESTOWN
PATRICK RUSSELL, 31 TUFTS ST. CHARLESTOWN
JOSEPH GOWIN, 50 SULLIVAN ST. CHARLESTOWN
KIM PAVER, 50 SULLIVAN ST. CHARLESTOWN
STEPHEN CHILDS, 4 CONCORD ST. CHARLESTOWN
MELINDA WHITE, 17 MCNULTY CT. CHARLESTOWN
PAULEEN O'DONNELL, 58 MONUMENT ST. CHARLESTOWN
CHRIS CAMPBELL, 50 MONUMENT ST. CHARLESTOWN
DENISE OWENS, 26 O'BRIEN CT. CHARLESTOWN
DEBARAH MARRERIO, 50 MONUMENT ST. CHARLESTOWN
PAUL MARTELL, 21 CHRYSTAL PLACE, CHARLESTOWN
CAROLYN A. DOHERTY, 84 OLD IRONSIDES WAY, CHARLESTOWN
LISA COLLINS, 47A OLD LANDING WAY, CHARLESTOWN
ELIZABETH BLACKSTONE, 110 OLD IRONSIDES WAY, CHARLESTOWN
PHYLLIS BELYEA, 184 BUNKER HILL ST. CHARLESTOWN
RUTH SWEENEY, 39 OLD LANDING WAY, CHARLESTOWN
BRENDA POLIPY, 177 BUNKER HILL ST. CHARLESTOWN
DONNA GRILLO, 2 CARNEY CT. CHARLESTOWN
ELIZABETH AWBREY, 25 CARNEY CT. CHARLESTOWN
MARIA ROSE, 25 CARNEY CT. CHARLESTOWN
DONNA MARTIN, 18 CARNEY CT. CHARLESTOWN
MAUREEN GOULD, 49 WALFORD WAY, CHARLESTOWN
DELIGHT TAMBERELLO, 62 DECATOR ST. CHARLESTOWN
JACQUELINE ROBINSON, 26 WALFORD WAY, CHARLESTOWN
DENISE TIERNEY COLBY, 121 WALFORD WAY, CHARLESTOWN
DAVID MANCUSO, 139 WALFORD WAY, CHARLESTOWN
DENISE SULLIVAN, 73 POLK ST. CHARLESTOWN
RUSSELL DESMOND, 110 MEDFORD ST. CHARLESTOWN
WILLIAM BOUREAU, 170 MEDFORD ST. CHARLESTOWN
MATTHEW AUCH, 58 MONUMENT ST. CHARLESTOWN
GENEVA IRWINN, 33 STAR KING CT. CHARLESTOWN
KAREN BYRNES, 33 STAR KING CT. CHARLESTOWN
MARJORIE DAVIS, 51A OLD IRONSIDES WAY, CHARLESTOWN
ROBERT M. HENNESSEY, 37-D OLD IRONSIDES WAY, CHARLESTOWN
PAMELA MACOMBER, 35-C OLD IRONSIDES WAY, CHARLESTOWN
CHERYL SCADDING, 10 OLD IRONSIDES WAY, CHARLESTOWN
MARK SKINNER, 91-C OLD IRONSIDES WAY, CHARLESTOWN
JULIA SKINNER, 91-C OLD IRONSIDES WAY, CHARLESTOWN
ANNA BRENNAN, 44 OLD IRONSIDES WAY, CHARLESTOWN
COLLEN JUSTICE, 71D OLD IRONSIDES WAY, CHARLESTOWN
KAREN KELLY, 73D OLD IRONSIDES WAY, CHARLESTOWN
PAULINE CALEMAR, 71 OLD IRONSIDES WAY, CHARLESTOWN

INIELL SCADDING, 31 OLD IRONSIDES WAY, CHARLESTOWN
MARGARET A. DOHERTY, 47 OLD IRONSIDES WAY, CHARLESTOWN
EILEEN KELLY, 87A OLD IRONSIDES WAY, CHARLESTOWN
DIANNA GALLEGHER, 233 OLD IRONSIDES WAY, CHARLESTOWN
DANIELLE DOE, 54 BELMONT ST., CHARLESTOWN
CHRIS RUSSELL, 77 MONUMENT ST., CHARLESTOWN
JOE MERTO, 58 MONUMENT STREET, CHARLESTOWN
BARBARA MARTIN, 58 MONUMENT ST., CHARLESTOWN
CAROL MCCEARY, 58 MONUMENT ST., CHARLESTOWN
KEMBERLY ROBINSON, 65 BUNKER HILL ST., CHARLESTOWN
MICHAEL NELSON, 137 BUNKER HILL ST., CHARLESTOWN
MARY DWYER, 145 BUNKER HILL ST., CHARLESTOWN
CAROLANN BELYEA, 184 BUNKER HILL ST., CHARLESTOWN
ROBERT CONNOLLY, 121 OLD IRONSIDES WAY, CHARLESTOWN
MEL STILLMAN, 41 DUNSTABLE ST. CHARLESTOWN
CHRISTINE CHIAPPA, 66 OLD IRONSIDES WAY, CHARLESTOWN
SUSAN R. FERRY, 105 BUNKER HILL ST., CHARLESTOWN
MARGARET DOHERTY, 47A OLD IRONSIDES WAY, CHARLESTOWN
RUSS DINUCCI, 75A OLD IRONSIDES WAY, CHARLESTOWN
DONNA RUSECKY, 63A OLD IRONSIDES WAY, CHARLESTOWN
LAURIE MCCOMISKEY, 73 OLD IRONSIDES WAY, CHARLESTOWN
ROBERT CARILL, 43 OLD IRONSIDES WAY, CHARLESTOWN
IRENE O'BRIEN, 79A OLD IRONSIDES WAY, CHARLESTOWN
PAUL O'BRIEN, 79 OLD IRONSIDES WAY, CHARLESTOWN
DONNA PASSAMONTI, 46 OLD IRONSIDES WAY, CHARLESTOWN
CONNY PHILLIPS, 72 OLD IRONSIDES WAY, CHARLESTOWN
MICHAEL GORMAN, 11 ELLWOOD ST., CHARLESTOWN
KENNETH GIORDANO, 17 COOK ST., CHARLESTOWN
CHRIS BRENNAN, 8 BELMONT ST., CHARLESTOWN
SHANNON LAWLER, 29 MEAD ST., CHARLESTOWN
PATRICK OWENS, 76 OLD LANDILNG WAY, CHARLESTOWN
MELANIE MARSDEN, 38 MYSTIC ST., CHARLESTOWN
JESSICA SWEENEY 38 OLD LANDING WAY, CHARLESTOWN
SHANNON MCLAUGHLIN, 320A MAIN ST., CHARLESTOWN
MICHELLE MACOMBER, 35C OLD IRONSIDES WAY CHARLESTOWN
CAROLYN SHANNON, 8 MYSTIC PLACE CHARLESTOWN
JAMES HINGSTON, 450 MAIN ST. CHARLESTOWN
JOHN P. MCNEIL, 43 OLD LANDING WAY CHARLESTOWN
EDWARD DYER, 12 COOK ST. CHARLESTOWN
DANIEL SULLIVAN, 176 BUNKER HILL ST. CHARLESTOWN
EDWARD J. WHELOCK, 9 SAMUEL MORSE WAY, CHARLESTOWN
CHRISTOPHER WHALEEN, 162 MONUMENT ST. CHARLESTOWN
RICHARD SCADDING, CHARLESTOWN
MICHAEL RACHUK, 130 WALFORD WAY CHARLESTOWN
ARLENE SMITH 28 CROSS ST. CHARLESTOWN
JOSEPH MCGONAGLE, 39 MYSTIC ST. CHARLESTOWN
DONALD GIBBONS, 17 UNION ST. CHARLESTOWN
HELEN LAVALLE, 33A TIBBETTSTOWN WAY, CHARLESTOWN

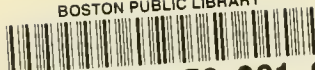
PAULINE O'NEIL, 381 MAIN ST. CHARLESTOWN
PHILIP LILLE, 385 MAIN ST. CHARLESTOWN
PATRICK WALSH, 85 ELM ST. CHARLESTOWN
KRISTIN WALSH, 85 ELM ST. CHARLESTOWN
ROBERT ROTHINGHAM, 26 UNION ST. CHARLESTOWN
JOSEPH KELLY, 85 ELM ST. CHARLESTOWN
HELEN FLAHERTY, 62 WASHINGTON ST. CHARLESTOWN
MARY DESTEFINO, 26 MAIN ST. CHARLESTOWN
KENDELL GUILFORD, 64 WASHINGTON ST. CHARLESTOWN
HELEN GALLAGHER, 9 LAWRENCE ST. CHARLESTOWN
LOUSIE GOSE, 9 MIDDLESEX ST. CHARLESTOWN
JOHN GODELL, 391 MAIN ST. CHARLESTOWN
DOROTHY EMERSON, 121 BUNKER HILL ST. CHARLESTOWN
ALBERT REILLY, 75 LAWRENCE ST. CHARLESTOWN
JEAN REILLY, 75 LAWRENCE ST. CHARLESTOWN
ANN HOEY, 10 MEAD ST. CHARLESTOWN
ALFONSO GAUVENTE, 10 MEAD ST. CHARLESTOWN
EVELYN CHRISTIAN, 384 MAIN ST. CHARLESTOWN
MARIE STELLA, 3 CRYSTLE PL. CHARLESTOWN
KAROLINE MARTINO, 13 WOOD ST. CHARLESTOWN
ANN MARTIN, 402 MAIN ST. CHARLESTOWN
ELIZABETH DONAHUE, 32 AUBURN ST. CHARLESTOWN
MARY SMALL 16 ST. MARTIN ST. CHARLESTOWN
HELEN FRASEIR, 384 MAIN ST. CHARLESTOWN
DENNIS SULLIVAN, 26 UNION ST. CHARLESTOWN
ALICE F. O'LEARY, 92 MONUMENT ST. CHARLESTOWN
DANIEL O'LEARY, 114 RUTHERFORD AVE. CHARLESTOWN
RICHARD BIELSKI, 54 WASHINGTON ST. CHARLESTOWN
SARAH CLARKE, 5 LAWRENCE ST. CHARLESTOWN
BEVERLY GIBBONS, 17 UNION ST. CHARLESTOWN
EDWIN COUITIBILT, 384 MAIN ST. CHARLESTOWN
WILLIAM BURKE, 89 PEARL ST. CHARLESTOWN
RITA BAKER, 381 MAIN ST. CHARLESTOWN
GEORGE CARNEY, 3 HAWTHORN PL. CHARLESTOWN
HELEN CARNEY, 3 HAWTHORN PL. CHARLESTOWN
MARY MADDEN, 137 BUNKER HILL ST. CHARLESTOWN
HELEN MAHONEY, 55 BALDWIN ST. CHARLESTOWN
JOHN MORGAN, 42 OLD IRONSIDES WAY CHARLESTOWN
EMANUEL N. STRANO, 34 GREEN ST. CHARLESTOWN
ANTHONY MARTINO, 12 WOODS ST. CHARLESTOWN
SHELIA WALSH, 33A TIBBETSTOWN WAY, CHARLESTOWN
ANN HOEY, 375 MAIN ST. CHARLESTOWN
MARY DEWEY, 86 TIBBETSTOWN WAY, CHARLESTOWN
CONNIE GANI, 391 MAIN ST. CHARLESTOWN
KATHERINE CONNOLLY, 24 MONUMENT ST. CHARLESTOWN
BAETRICE WALSH, 42 MT. VERNON ST. CHARLESTOWN
HELEN KORINSKI, 390 MAIN ST. CHARLESTOWN
MARY KELLY, 85 ELM ST. CHARLESTOWN

MARIE MARSDEN, 37 MYSTIC ST. CHARLESTOWN
CATHERINE F. RYLE, 390 MAIN ST. CHARLESTOWN
PHILOMENA WARD, 391 MAIN ST. CHARLESTOWN
BRIAN MCNICHOLAS, 17 POLK ST. CHARLESTOWN
JAMES CUSHMAN, 10 OLD RUTHERFORD AVE. CHARLESTOWN
MATTHEW O'NEIL 23 CROSS ST. CHARLESTOWN
NEIL E, GRIFFIN, 50 MONUMENT ST. CHARLESTOWN
FRANK STILLMAN 148 BUNKER HILL ST. CHARLESTOWN
PATRICK J. CONSIDINE 77 MONUMENT ST. CHARLESTOWN
MICHAEL YANDLE, 39 AUBURN ST. CHARLESTOWN
MICHAEL MURPHY, 12 SHEAFE ST. CHARLESTOWN
RICHARD GRIFFIN, 26 CEDAR ST. CHARLESTOWN
BRIAN DORIS, 24 EDEN ST. CHARLESTOWN
DENNIS DORIS, 45 CHAPPIE ST. CHARLESTOWN
JANE CELLA, 35 SACKVILLE ST. CHARLESTOWN
ROBERT J. CELLA, 35 SACKVILLE ST. CHARLESTOWN
JOHN BRAZIL, JR. 28 HIGH ST. CHARLESTOWN
THOMAS DONAHUE, 19 PHIPPS ST. CHARLESTOWN
WILLIAM GRIFFIN, 20 COOK ST. CHARLESTOWN
JAMES YANDLE, 70 TIBBETSTOWN WAY CHARLESTOWN
JOSEPH YANDLE, 70 TIBBETSTOWN WAY CHARLESTOWN
ROBERT GARCEAU, 42 PARK ST. CHARLESTOWN
GEORGE GARCEAU, 42 PARK ST. CHARLESTOWN
JOAN CROWLEY, 9 CARNEY CT. CHARLESTOWN,
MARK GRIFFIN, 38 ST. MARTIN ST. CHARLESTOWN
SUSAN MCCLELLON, ELM ST. CHARLESTOWN
BRIAN GRIFFIN, 38 ST. MARTIN ST. CHARLESTOWN
ROBERT P. DELANEY, 26 PEARL ST. CHARLESTOWN
JEFFERY E. JONES, 132 BUNKER HILL ST. CHARLESTOWN
MAUREEN WOODS, 24 PROSPECT ST. CHARLESTOWN
JOHN H. SAWYER, JR. 329 BUNKER HILL ST. CHARLESTOWN
GERALD R. CONNERS, 25 PHIPPS ST. CHARLESTOWN
THOMAS E. DONAVAN, 510 MEDFORD ST. CHARLESTOWN
JOHN DOHERTY, 25 RUSSELL ST. CHARLESTOWN
EDWARD CLARK, 59B OLD IRONSIDES WAY CHARLESTOWN
PAUL MCNELLEY, 3 MAIN ST. CHARLESTOWN
PAUL MYERS, 2A DUNSTABLE ST. CHARLESTOWN
WILLIAM MCCLELLON, ELM ST. CHARLESTOWN
JOHN T. SULLIVAN, 85 MAIN ST. CHARLESTOWN
PATRICK CONSIDINE, 77 MONUMENT ST. CHARLESTOWN
ROBERT COLLINS, 1 MYSTIC ST. CHARLESTOWN
JOHN O'DONNELL 72 BUNKER HILL ST. CHARLESTOWN
CHRISTOPHER SAVOYER, 329 BUNKER HILL ST. CHARLESTOWN
PHILIP C. JONES, 107 MEDFORD ST. CHARLESTOWN
GERARD T. BUCKLEY, 106a DUNSTABLE ST. CHARLESTOWN
ROBERT HANLEY, 20 UNION ST. CHARLESTOWN
STEPHEN OWENS, 104 BALDWIN ST. CHARLESTOWN
GARY JUSTICE, 6 COOK ST. CHARLESTOWN

JAMES HANLEY 24 C OLD LANDING ST. CHARLESTOWN
HUGH CARROLL 4 TRENTON ST. CHARLESTOWN
CAROLE J. HAINS, 17 MT. VERNON ST. CHARLESTOWN
CAROLINE SVUARES, 14 WINTHROP ST. CHARLESTOWN
MICHELE PRINCE, 108 MAIN ST. CHARLESTOWN
MICHAEL FITZPATRICK, 17 COREY ST CHARLESTOWN
PETER MANSFIELD, 65 O'REILLY WAY CHARLESTOWN
GARY MCNEIL, 67 OLD LANDING WAY CHARLESTOWN
PHILIP EATHERTON, 82 OLD LANDING WAY, CHARLESTOWN
DAVID JACKSON, 68 TREMONT ST. CHARLESTOWN
JOSEPH PORTER, 34 SOLEY ST. CHARLESTOWN
PAUL MCKINLEY, 2 CHAPPIE ST. CHARLESTOWN
TERRY CONROY, 10 9TH ST. CHARLESTOWN
GEORGE O'CONNOR, 4 SHEAFE ST. CHARLESTOWN
WILLIAM KELLY, 70 FERRIN ST. CHARLESTOWN
RICHARD MCCARTHY, 34 SHIPWAY PL. CHARLESTOWN
EDWARD KAVANAGH, 40 ELM ST. CHARLESTOWN
KENNETH MCCREEVAN, 11 ELWOOD ST. CHARLESTOWN
PAUL ANTHONY, 19 MONUMENT AVE. CHARLESTOWN
MARK SMITH 56 BELMONT ST. CHARLESTOWN
DAVID CHAMBERLIN, 66 O'BRIEN CT. CHARLESTOWN 100
MARK G. DOWD, 104 OLD IRONSIDES WAY CHARLESTOWN
ALBERT SULLIVAN, 56 UNION ST. CHARLESTOWN
EUGENE SIMPSON, 6 CONCORD ST. CHARLESTOWN
ROBERT H. STEWARD, 441 MAIN ST. CHARLESTOWN
JOHN DOWD, 104 IRONSIDES WAY, CHARLESTOWN
JAMES T. KANE, 5 FOREST PL. CHARLESTOWN
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